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WHBN 00-07

Welsh Health Building Note

Planning for a resilient healthcare estate



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Welsh Health Building Note 00-07 Planning for a resilient healthcare estate

Overview

Welsh Health Building Note (WHBN) 00-07 provides guidance for NHS Wales-funded providers on designing and planning for a resilient healthcare estate. It aims to help NHS Wales organisations to determine appropriate levels of resilience for sites, buildings and installations against a wide range of emergencies, hazards and threats and their impacts and consequences including resilience to the impacts of climate change. This document focuses on:

- the strategic approach to resilience planning for healthcare estates;
- procuring resilient healthcare estates;
- design and planning considerations for a resilient healthcare estate;
- resilience of building services engineering.

It also embraces the move towards a whole-system approach to healthcare. The isolated approach of concentrating on the resilience of a single facility or organisation is no longer considered best practice. It is clear that this approach will affect building and services infrastructure requirements for the future and should be taken into account at the strategic planning stage for all new healthcare estates and facilities, and also when refurbishing or decommissioning the existing estate.

Relevance and audience

The guidance is relevant to the whole healthcare estate including private sector premises providing services to NHS Wales (hereinafter referred to as “NHS Wales-funded providers”); to those who advise and support them; and to associated supply chains.

It is applicable to new schemes, refurbishments, decommissioning and existing facilities. It takes into account the importance of resilience to ensure business continuity management (BCM) and aligns with the Integrated Emergency Management (IEM) model.

The WHBN will be useful for a wide range of specialists, including (but not limited to):

- capital project teams;
- estates and facilities managers;
- healthcare engineers;
- architects and designers;
- healthcare planners;
- sustainability managers;

- IT and communication teams;
- lead officers for emergency preparedness/civil contingencies;
- emergency planning liaison officers and teams;
- clinician/medical teams involved with emergency planning;
- managers and directors including those executives with security and/or emergency planning portfolios.

It is essential that throughout the whole process of procuring and maintaining healthcare, the estates/facilities manager should communicate and work in close cooperation with the lead officer for emergency preparedness/civil contingencies. This will ensure that the resilience of the healthcare estate including climate change is integrated into the organisation's board-approved strategies, systems, training, policies and procedures.

The need for this guidance

This WHBN has been revised to reflect the increasing long-term risks associated with climate change. UK climate change risk assessment 2017 (CCRA)(Committee on Climate Change 2016) shows that flooding is one of the largest risks for the UK. Therefore, this document has been updated to provide more guidance on adaptation measures to reflect this and other climate change impacts such as floods and heatwaves.

To assist in assuring compliance with relevant legislation and government policy, this WHBN provides advice on the planning, design, construction, commissioning and operation of NHS Wales-funded healthcare facilities. In particular, it has been developed to respond to the following key drivers:

- The initial CCRA in 2012 identified the key risks to the UK from climate change as being the first step towards development of the National Adaptation Programme (NAP) (HM Government 2013b). It acknowledged that building climate resilience is an ongoing investment and that a start needed to be made, particularly for risks where decisions have long-term consequences (for example, planning for a climate-resilient healthcare estate).
- The top risks for the UK identified in the CCRA were addressed in the 2013 NAP. This includes a health chapter for healthy and resilient communities, with this updated guidance specifically addressing health objective 12: '*to promote climate resilience within the NHS, public health and care system to ensure continuity of services and resilient assets/estates, including the ability to deal with the increased demand for services associated with severe weather-related events*' (pg 47).

Changes since the last edition

- This revision updates the WHBN in line with new government policy, legislation and regulations.
- More guidance has been provided on the risks associated with climate change, and this is reflected in the specific advice given in the planning and design chapter.
- The resilience of engineering infrastructure has been expanded upon to reflect the critical nature of maintaining continuity of these services for healthcare delivery.
- The document still reflects the benefits of the IEM model, but the detail has been reduced and the reader has been signposted to other more relevant sources of information.
- It has revised, updated and incorporated the emergency planning and contingency sections that were in earlier editions of WHTM 00:2014 *Policies and principles of healthcare engineering*.

Acknowledgements

WHBN 00-07 *Planning for a resilient healthcare estate*, is based on the Department of Health's HBN 00-07:2014 *Planning for a resilient healthcare estate*. NHS Wales Shared Services Partnership – Specialist Estates Services is grateful to the Department of Health for permission to adapt the original guidance for application in Wales. The contents of the original document were reviewed by NHS Wales Shared Services Partnership – Specialist Estates Services and by representatives of health boards and Trusts in Wales and Welsh Government.

Abbreviations

BCM	Business continuity management
BCP	Business continuity plan
BIM	Building information modelling
BMS	Building management system
CCRA	UK Climate change risk assessment [Committee on Climate Change 2016]
CHP	Combined heat and power
DCLG	Department for Communities and Local Government
EPLO	Emergency planning liaison officer
FM	Facilities management
FRA	Flood risk assessment
IEM	Integrated Emergency Management
KPIs	Key performance indicators
LRF	Local resilience forum
NAP	National Adaptation Programme
NRW	National Resources Wales
PA	Public address
SuDS	Sustainable drainage systems
UPS	Uninterruptible power supplies
WHBN	Welsh Health Building Note
WHTM	Welsh Health Technical Memorandum
WRF	All Wales Resilience Forum

Definitions

For the purposes of this guidance the following definitions apply:

Adaptation – relates to changes made in readiness for, or in response to, the impacts of climate change.

Business continuity management – all activities undertaken to give NHS Wales facilities the capacity to anticipate, prevent, prepare for, respond to and recover from disruptive challenges that would otherwise prevent the organisation from meeting its primary duties. The term subsumes resilience and resilience management.

Emergency – with regard to estates and facilities, this includes:

- a major incident;
- an unexpected event that gives rise to loss of, or damage to, facilities or services that may impact on the delivery of healthcare;
- an event or situation that threatens serious damage to the environment of a place in the UK, or war or terrorism which threatens serious damage to the security of the UK.

Hazards – non-malicious events including natural events, industrial accidents and industrial action.

Healthcare facility – all buildings, infrastructure, equipment, plant, embedded systems and related items that support the delivery of healthcare and services of all types, irrespective of their ownership or operation by third parties.

Lockdown – refers to controlling the movement and access of people around a Trust site or area in response to an identified risk, threat or hazard that might impact on the security of patients or assets.

Mitigation – relates to actions to limit the magnitude and/or rate of long-term climate change. Mitigation generally involves reductions in human-related emissions of greenhouse gases. Mitigation may be achieved by switching to low carbon energy sources such as renewable energy.

Recovery – the process of rebuilding, restoring or refurbishing a healthcare facility following an emergency, hazard or threat.

Resilience – the ability of an organisation to adapt and respond to disruptions, whether internal or external, to deliver organisationally agreed critical activities.

Surge capacity – the ability of a health service to expand beyond normal capacity to meet increased demand for clinical care. This is an important factor of resilience and emergency preparedness and should be addressed early in the planning process.

Threats – malicious attacks.

Whole system approach – any resilience planning should be integrated and take into account the whole healthcare system, including acute, community, primary and voluntary sectors. For example, not only do hospitals have to deal with the usual intake of patients during a severe event, but also with disaster-related patients and patients with chronic illnesses who are usually cared for at home, but who suddenly do not have access to the medical technologies they need.

Contents

Overview

Acknowledgements

Abbreviations

Definitions

- Chapter 1** **Introduction**
 The whole system approach to healthcare estates resilience
 Purpose and scope
 Relevant legislation that impacts on the resilience of the healthcare estate
 Key drivers
- Chapter 2** **The strategic approach to resilience planning for healthcare estates**
 Strategic planning tools and models supporting a resilient healthcare estate
 Risk assessment
- Chapter 3** **Procuring resilient healthcare estates**
 Incorporating resilience requirements into the project brief
 The design brief
 Review the design proposal
 Controlling delivery of resilience
- Chapter 4** **Design and planning considerations for a resilient healthcare estate**
 Site-wide design considerations for resilience
 Designing for resilience to the impacts of climate change
 Blast-resistant building design considerations
 Access to documentation
- Chapter 5** **Resilience of building services engineering**
 Resilient infrastructure and supply
 Emergency plans for engineering services

Appendix 1 Design proposal review

Impacts of loss of power, water, drainage, sewage and transport – example questions to mitigate impacts on healthcare organisations

Scenario 1 – Mains water supply fails for three days

Scenario 2 – Mains electricity fails for 24 hours

Scenario 3 – Loss of telephone communications for up to five

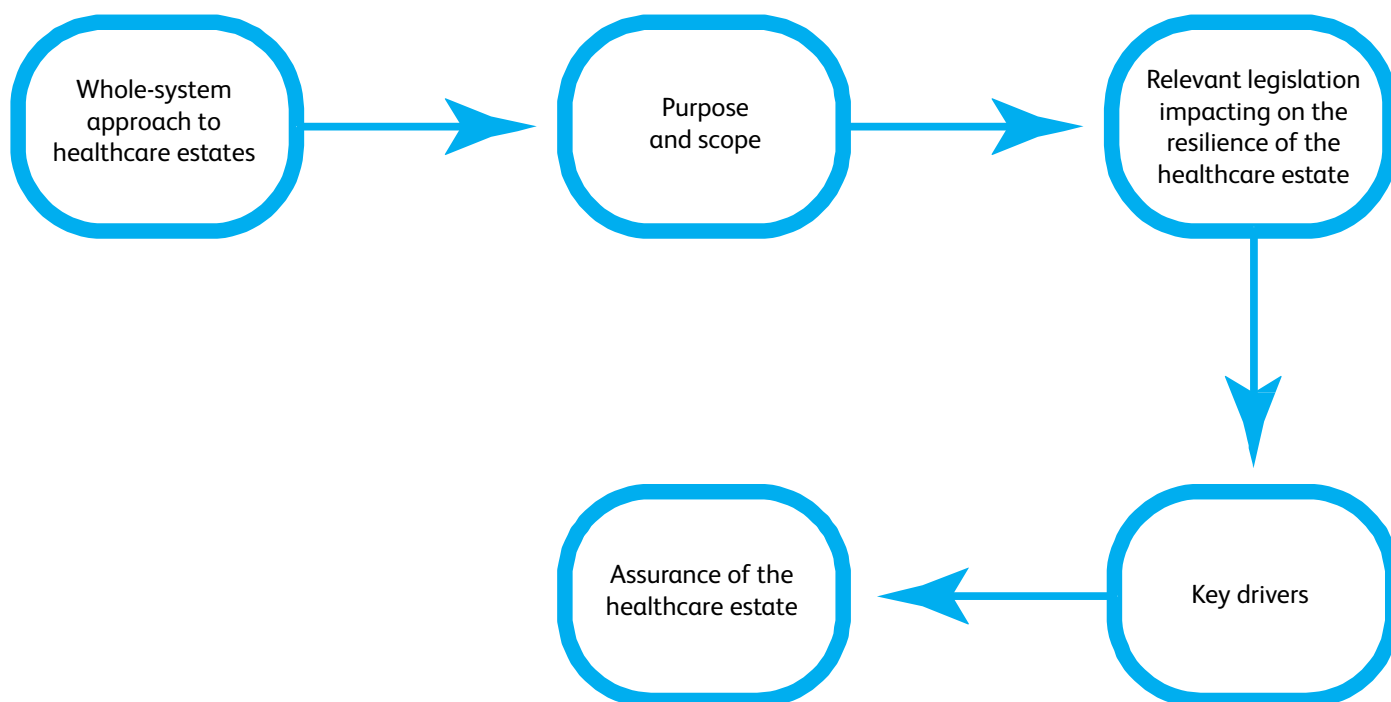
Appendix 2 Case study. Ysbyty Ystrad Fawr local general hospital

References

1

Chapter 1

Introduction



For the purpose of this document, resilience is defined as *‘the ability of an organisation to adapt and respond to disruptions, whether internal or external, to deliver organisationally agreed critical activities’*. This builds on the definition of ‘resilience’ in BS ISO 22301:2014 and includes resilience to the impacts of climate change such as the increased extreme weather events of heatwaves and flooding.

Resilient facilities are those that have the following features:

- robustness – the system or facility should be able to absorb the effects of an event and continue to operate at the required level;
- redundancy – where robustness cannot be absolutely guaranteed, it is essential to provide more than one key facility or subsystem;
- reconfigurability – the unanticipated risk is often the most devastating. To be truly resilient, a system or facility should be adaptable to cope with the effects of an unexpected event, where practicable.



- 1.1 The resilience process aims to identify emergencies, hazards and threats, assess the associated risks, develop measures to mitigate those risks, and prepare plans for response to an emergency should it occur.
- 1.2 This document focuses on improving the resilience of the existing estate and its facilities management (FM) as well as new builds and refurbishments:
 - For the existing estate and FM, resilience requires that plans are put in place to ensure that business continuity of healthcare is maintained no matter what the circumstances.
 - Resilience should be considered early in the procurement/planning and design process/stages. Particular attention should be paid to flexibility in facility design in order to accommodate surge capacity and peaks in demand.

The whole system approach to healthcare estates resilience

- 1.3 Existing operational capability and resilience planning should take into account the whole healthcare system, including acute, community, primary and voluntary sectors. For example, hospitals have to deal not only with the usual intake of patients during a severe event, but also with the casualties caused by the disaster and those patients with chronic illnesses who are usually cared for at home but who suddenly do not have access to the medical technologies they need.

Purpose and scope

- 1.4 This document provides guidance on planning for a resilient healthcare estate. It aims to help NHS Wales-funded providers to determine appropriate levels of resilience for sites, buildings and installations against a wide range of emergencies, hazards and threats and their impacts and consequences. The document provides guidance on:
 - the strategic approach to resilience planning for healthcare estates;
 - procuring resilient healthcare estates;
 - design and planning considerations for a resilient healthcare estate;
 - resilience of building services engineering.
- 1.5 This WHBN is consistent with Welsh Government policy and arrangements for planning for health emergencies. It complies with wider government plans for national and local emergencies.



Relevant legislation that impacts on the resilience of the healthcare estate

1.6 The following main Acts and regulations are relevant to the resilience of the healthcare estate:

- The *Civil Contingencies Act 2004* requires NHS organisations, its subcontractors and providers of NHS Wales-funded care to show that they can deal with such incidents and emergencies while maintaining services to patients.
- The *Climate Change Act 2008* established the target of reducing UK greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050. Reducing demand for energy, buildings and infrastructure will be more efficient and will reduce energy bills, but will also make organisations, and the country as a whole, more resilient through climate adaptation measures.
- The *Well-being of Future Generations (Wales) Act 2015* is about improving the social, economic, environmental and cultural well-being of Wales. The Act will make the public bodies listed: think more about the long term; work better with people and communities and each other; look to prevent problems and take a more joined-up sustainable approach.
- The *Environment (Wales) Act 2016* puts in place legislation to plan and manage Wales' natural resources. Key parts of the Act include climate change powers to put in place statutory emission reduction targets and carbon budgeting. Additionally it includes waste management powers to achieve higher levels of business waste recycling, better food waste treatment and increased energy recovery.

Key drivers

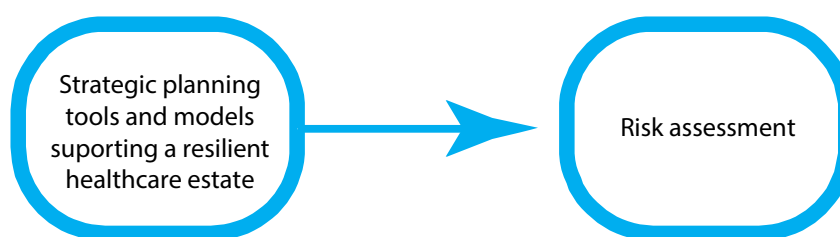
1.7 To assist in assuring compliance with relevant legislation and government policy, this WHBN is driven by:

- the *National Adaptation Programme (NAP)* health objective 12: “to promote climate resilience within the NHS, public health and care system to ensure continuity of services and resilient assets/ estates, including the ability to deal with severe weather-related events”;
- the *UK climate change risk assessment (CCRA)* (Committee on Climate Change 2016). This acknowledges that building resilience is an ongoing investment and that a start needs to be made now, particularly for those risks where decisions have long-term consequences (for example, planning for a resilient healthcare estate). The CCRA is the first step towards development of the NAP.

2

Chapter 2

The strategic approach to resilience planning for healthcare estates



- 2.1 The healthcare sector's built environment and support services are the core element in an organisation's ability to maintain its business-prioritised activities.
- 2.2 Estates and facilities managers will need to consider a business continuity approach for buildings, infrastructure and services resilience, which needs to form part of the wider organisational approach to resilience. This is essential to maintain clinical services and should also take into account the need for surge capacity (that is, the ability of the health service to meet increased demand for clinical care).
- 2.3 Robust procedures should be prepared and tested for the following priority incidents as a minimum:
 - unavailability of premises due to fire, flood, fuel shortages or other incidents;
 - major problems relating to the transport infrastructure that affect access and egress for healthcare professionals, patients and visitors;
 - major electronic attacks or severe disruption to the IT network, systems and mobile telephony;
 - loss of access to key resources, assets, utilities and fuel supply;
 - theft or criminal damage that severely compromises the organisation's physical assets;
 - significant chemical contamination of the working environment;
 - loss of critical support services or the supply chain.



- 2.4 NHS Wales-funded organisations will need to undertake regular risk assessment exercises appropriate to their facilities and services. For further guidance on business continuity management (BCM) and business continuity plans (BCPs), readers should refer to:
- *Emergency preparedness* (Cabinet Office 2012), Chapter 6;
 - *NHS Wales emergency planning core guidance* (Welsh Government 2015a)
 - *NHS resilience and business continuity management guidance* (Welsh Assembly Government 2008)
- 2.5 BS ISO 22301:2014 on BCM provides a generic framework that covers strategies in all phases before, during and after an incident.

Strategic planning tools and models supporting a resilient healthcare estate

- 2.6 Described below are a number of available tools and resources for use by NHS Wales-funded providers as appropriate to their local needs and circumstances.

World Health Organization (WHO) tools and resources

Hospital emergency response checklist

- 2.7 *The Hospital emergency response checklist* (WHO 2011) is a tool for hospital administrators and emergency managers. The guidance and its checklists assist hospital-based emergency managers to respond effectively. The best practice guidance integrates priority actions required for rapid effective response to critical event-based all-hazard approaches.
- 2.8 It is structured according to a number of key components, each with a list of priority actions to support healthcare managers and emergency planners in achieving the essentials for healthcare estates resilience:
- continuity of essential services;
 - well-coordinated implementation of operations at every level;
 - clear and accurate internal and external communication;
 - swift adaptation to increased demands;
 - the effective use of scarce resources;
 - a safe environment for healthcare workers.



Hospital safety index

2.9 The *Hospital safety index*, a tool devised by WHO and PAHO, and available from the PAHO website at: <http://www1.paho.org/english/dd/ped/SafeHospitalsChecklist.htm> provides a rapid diagnosis of the safety, vulnerability and preparedness of hospitals. The results of the assessments inform decision makers about which hospitals could withstand the impact of hazards and deliver health services in emergency situations, and those which require remedial action to make them safe and operational in times of emergency.

The Integrated Emergency Management (IEM) model

2.10 The IEM model is a holistic approach to preventing and managing emergencies that entails six key steps (see [paragraph 2.11](#)). Although there are other approaches to emergency management, the IEM model is adopted by this WHBN not least because it:

- implements the common and consistent UK national model for the anticipation, assessment, mitigation and management of physical risks into the healthcare environment;
- defines a common set of words and processes, thereby minimising the risk of misunderstandings;
- facilitates the integration of site- and event-specific risk assessments and plans into the wider risk and emergency arrangements of other involved agencies;
- provides common ground for effective discourse between the organisations directly involved, the emergency services, and the many external agencies that may become engaged at different stages of any event or emergency and with varying degrees of intensity.

2.11 The IEM model describes a series of cyclical processes. It is essential to view the elements of the IEM as mutually-supporting processes and not as sequential steps, as the first four of the six are continuous, connected activities:

- a. anticipation,
- b. assessment,
- c. prevention,
- d. preparation,
- e. response,
- f. recovery.



- 2.12 For further details on the IEM model and these six steps, see the Cabinet Office's (2012) *Emergency preparedness* and HM Government's *Emergency response and recovery* (2013a) guidance documents.

Risk assessment

- 2.13 For the estates and facilities manager, one of the main objectives of resilience is to undertake a risk assessment and to identify gaps in the overall capacity for managing the healthcare estate and to ensure the continued operation of its facilities, services and functions to maintain healthcare services during a crisis. The aim is to develop a plan of action to address those gaps and strengthen capacity. Follow-up assessments should be conducted at least every two years.
- 2.14 Every local situation will differ, but consideration should be given to how the building's location, form and design could help in anticipating, preparing for, preventing, responding to, and recovering from disruptions whatever their source and whatever part of the business they affect.
- 2.15 Risk assessment plans should include a hazard-and-threat analysis as part of the decision-making process to take account of the issues addressed below.
- 2.16 Users will need to reference (among others):
- National Risk Register (<https://www.gov.uk/guidance/risk-assessment-how-the-risk-of-emergencies-in-the-uk-is-assessed>)
 - Community Risk Register (<https://www.gov.uk/guidance/risk-assessment-how-the-risk-of-emergencies-in-the-uk-is-assessed>)
 - UK Climate Impacts Programme (<http://www.ukcip.org.uk>)
 - Emergency preparedness (Cabinet Office 2012).
- 2.17 The risk assessment should be periodically reviewed across the whole range of risks/threats to allow for any changes that may take place (for example, over time, a low risk may become a high-risk event). The review frequency should be linked to an automated email system, calendar or other bespoke software.

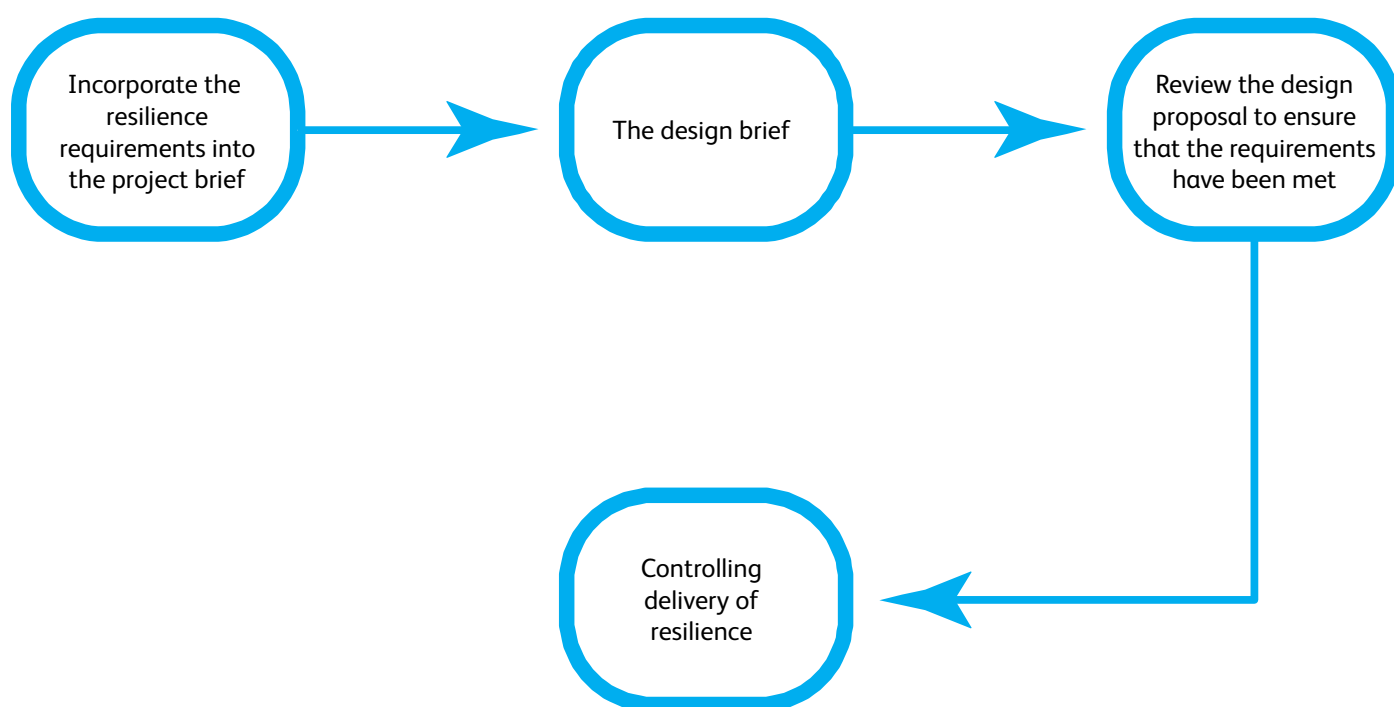


Issues to consider in a risk assessment plan (in no order of priority)

Utility supplies, ie, electricity, gas, water – how would healthcare be delivered without heating, cooling, gas and air handling, washing linen and dishes, cooking, powering blood banks, maintaining radiology services etc?
Water, drainage – loss of pumping mechanisms to provide clean water for drinking/hydration; water for cleanliness and control of infection.
Sewage – treatment failure could lead to untreated/undertreated sewage potentially contaminating local waterways leading to public health concerns and clean-up costs at a later date.
Accessibility/transport – what would happen without transport to the facility (for example contractors maintaining essential services; equipment/supplies that could not be delivered)? Engage with transport coordinators.
Flood plans – engage with the local environment agency and local planners to continually review the local flood model and ensure plans take account of adjacent or neighbouring developments that may affect surface water drainage.
Heatwave plan – ensure the design and layout allows for shading, temperature control and cool rooms for heat-distressed patients.
Cold weather plan – to support improved building design and increased energy efficiency, which can reduce carbon emissions, and improve and protect health (thereby potentially reducing pressure on health provision).
Winter pressures – can place more pressure on clinical services such as A&E services and acute care.
Infection prevention and control – can room availability and layouts contain the spread of airborne and waterborne viruses? Is there sufficient storage for necessary supplies and disposal of increased clinical/hazardous waste?
Extreme medical conditions – could the building facilitate lockdown of sections or rooms for containment?
Resilience for essential services – telecommunications, IT systems, utility services, medical gases and heating.
Supplies and procurement – how long can the organisation cope if supplies of drugs, food, medical equipment etc could not be delivered? What are the contingency plans for partner organisations to respond in times of emergency?
Fire/bomb threat – can the building be evacuated while maintaining care of the most critical patients?
Fuel shortages – how long would the facility function if fuel was in short supply?
Arson attacks
Civil aviation issues – is the building located in a flight path: what would this mean for major incident planning if a major air accident occurred? Does the building require an air ambulance facility?
Theft and vandalism.
Location – is the facility sited near to a chemical plant or other facility at risk of explosion etc?

Chapter 3

Procuring resilient healthcare estates



Introduction

- 3.1 If the strategic planning phase reveals that the facility needs to be redeveloped or relocated, the options for procuring this development should be appraised before a specific scheme is identified. These options will usually involve:
- no building work at all (including the decommissioning and the potential lease/ sale or demolition of existing buildings);
 - relocating or reassigning functions within the existing fabric of the building;
 - refurbishing existing buildings;
 - new developments.
- 3.2 This chapter explains how emergencies, hazards and threats can be dealt with throughout the procurement process to ensure that resilience is achieved.
- 3.3 In procuring a healthcare facility and the services/equipment that are required within it, designers, planners and clients will need to be assured that all premises and equipment used is safe, clean, secure, suitable for the purpose for which they are being used, and properly used and maintained.

- 3.4 Estates and facilities resilience should not be planned in isolation. For large projects (particularly new builds), the threat part of the assessment may be produced at regional or national level, and may include input from other sources. At a local level, advice should be sought from the local resilience forum (LRF), police architectural liaison officer or crime prevention design adviser, and local police counter-terrorist security advisers.

Incorporating resilience requirements into the project brief

- 3.5 The project brief should communicate the client's requirement for resilience to emergencies, hazards and threats to the design team. This is equally important when occupying and/or leasing premises that are not owned by the healthcare organisation. This is the start of the continuous process of assessment that should be undertaken as part of the facility's lifecycle.
- 3.6 Resilience measures should not be discounted or compromised on the basis of costs, as the NHS Wales-funded provider is the ultimate bearer of any risk to service provision. Therefore, the delivery mechanisms proposed for resilience should be scrutinised very closely and gauged against the overall benefits in the longer term.
- 3.7 To ensure that resilience is considered as a factor in the estates strategy, the following questions should be posed:
- How resilient is our estate? (What risks exist in our assessment that need to be addressed in the design?)
 - How resilient should it be? (What risks are unacceptably high?)
 - How can we improve our resilience? (What building or engineering measures can we apply to mitigate risks?)

The design brief

- 3.8 The design for resilience in any facility will depend on the assessed risk for that scheme at the time. Applying the guidance in this WHBN to a particular scheme for a particular locality will require skilful risk assessment due to the variability and likelihood of emergencies, hazards and threats in different parts of the country. A risk assessment will be required for each business case, and this will need to address the design brief, geographical location and any other mitigating local factors.
- 3.9 The design brief should take account of future-proofing, adaptability and flexibility of the building. Further advice on future-proofing of healthcare facilities is provided in chapter 8 of HTM 07-07:2011 *Sustainable health and social care buildings*.



Review the design proposal

- 3.10 Design proposals should be reviewed to assess whether the level of resilience meets the requirements set out in the project brief. In a simple facility purchase, this can be a straightforward review of the physical design, but where some form of leasing arrangement is proposed, the review should also include an operational assessment.
- 3.11 In terms of the current requirements, BCM and the IEM model described in [Chapter 2](#) should be used to enhance the project proposal as this is the point at which emergencies, hazards and threats can be prevented or prepared for.

Controlling delivery of resilience

- 3.12 Measuring resilience need not be complicated. In fact, the system should be as simple and unequivocal as possible. In common with other requirements stated in the project brief, the requirements should be tested and measured in the delivered project against the original output specification.
- 3.13 In a facility where service provision has been outsourced, responsibilities need to be clear. A useful mechanism to control and monitor the delivery of resilience requirements is to incentivise the contract with the use of performance monitoring tools such as key performance indicators (KPIs). This mechanism is of particular value to identify the requirements, since they are not products that are delivered but capabilities that are expected to be available.

Measuring resilience – an example

- 3.14 The following is an example of one type of risk that could be considered as part of a local risk management process when service provision has been outsourced.



The requirement

'Provision is to be made for an electricity supply system that is capable, in the absence of mains electricity, of sustaining the essential load of the facility for a period of X hours.'

Assessing whether the proposal satisfies the requirement

The measure is not just in the physical presence of a suitably-sized generator (or alternative), but also in the presence of:

- sufficient fuel for X hours' running;
- the necessary breakdown/maintenance cover;
- trained personnel to operate the generator system;
- proof that the system works in its design condition (that is, under continuous full load, not just that it starts).

Clarifying responsibilities

If the organisation owns the generator and the contractor is responsible for maintaining and operating it, where does responsibility lie for ensuring business continuity if it fails to start?

(Note: ultimately, no matter how the contract is written, the risk of loss of power lies with the NHS Wales-funded provider; therefore, ownership of the risk has not been transferred.)

Where the entire supply mechanism (generator, maintenance, operation) is outsourced, responsibilities are easier to define and less likely to produce gaps from which failures tend to arise, although there is a need to clarify and be confident of contingency plans and arrangements with suppliers.

Using key performance indicators

Negative KPIs (penalty or reduced payments):

- number of days when the standby generator was unavailable due to maintenance failure;
- number of days when trained personnel were unavailable.

Positive KPIs (bonus payments):

- a successful periodic test run of the generator under load;
- successful completion of a periodic test exercise.



Chapter 4

Design and planning considerations for a resilient healthcare estate



Introduction

- 4.1 Planning and designing for resilience whenever the opportunity arises – that is, when new sites/buildings or departments are being considered and when major refurbishments are taking place – is a key responsibility of the organisation or board of directors.
- 4.2 Clear requirements should be provided by the healthcare organisation at the planning and design stage to enable an appropriate level of resilience to be built in. For this purpose, close liaison should take place between the organisation’s lead officers for emergency preparedness/civil contingencies and the estates and facilities professionals, local planning authorities, and police architectural liaison officers/crime prevention design advisers. The All Wales Resilience Forum (WRF), LRFs, and emergency preparedness/civil contingencies officers and executive leads may also be able to advise on specific cases.
- 4.3 Local plans should take account of climate change over the longer term, including factors such as flood risk, coastal change, water supply and changes to biodiversity and landscape. New developments should be planned to avoid increased vulnerability to the range of impacts arising from climate change. When a new development is brought forward in vulnerable areas, care should be taken to ensure that risks can be managed through suitable adaptation measures, including the planning of green infrastructure.

Note on Building Information Modelling (BIM)

The government’s mandate is that the public sector will deliver centrally procured projects using BIM. BIM can be used for effective management of information throughout a project’s lifecycle – from earliest concept, design, build, operation and through to ultimate demolition. BIM also has the capability to accurately model the building and its energy performance. In addition, it can be applied in the design and analysis of a building in terms of resilience to climate change as different design parameters can be modelled and tested. It may be extremely valuable in the creation, storage and retrieval of data essential for resilience.



Site-wide design considerations for resilience

Site selection

- 4.4 Resilient design starts with the site option appraisal process as a means of selecting the most appropriate site. Adjacency to other buildings/types should also be considered as part of this process.
- 4.5 Site location, orientation and accessibility issues are also paramount. Project teams will need to engage with Natural Resources Wales (NRW), the local authority and the local highway authority to assess local conditions, for example:
- the likelihood of flood risk in the area whether due to the proximity of a floodplain or increased impact from neighbouring developments;
 - proximity and potential for impact from COMAH sites (see *Control of Major Accident Hazards Regulations 2015*).

Engagement through the wider community LRF will also be key.

- 4.6 Although hospitals and medical facilities are not often targets for terrorist attacks, other neighbouring facilities may be. Therefore, siting a prospective new-build near to a potential terrorist target (government, commercial or domestic building) may increase the risk of becoming involved in an incident. It should also be noted that city centres themselves, because of their symbolic nature or the potentially large number of people, have also been attacked.
- 4.7 It may also be beneficial to consider the resilience of key utilities where an adjacent incident may impact on the proposed site. Designers should look at the wider national infrastructure from which a proposed development will draw services to evaluate any additional need for on-site resilience.

Grounds and site layout

- 4.8 Having selected a site, the nature of the grounds and the layout of the facility should be considered to take advantage of natural geographical features or to determine how best to enhance them to withstand natural hazards (for example, by providing better drainage, such as sustainable drainage systems (SuDS), to avoid disruption caused by floods etc). Boundary fencing to control the flow of foot and vehicle traffic should also be considered.

Radon controls

- 4.9 Designers need to consider the implications of radon contamination within buildings. This is determined by various factors including the geology of the ground, construction details and factors such as the methods of heating and ventilation.



- 4.10 In outline, basic radon protective measures involve the fitting of a gas-tight ground barrier to protect against radon ingress. This, which also acts as a damp-proof membrane, should cover the whole building footprint and be lapped to the damp-proof course in the walls and sealed around service penetrations. Full radon protective measures require the radon-proof ground barrier, together with a sump in the foundation, to be designed and constructed such that a suitable extraction system can be installed if high levels of radon are detected after occupancy.

Road and vehicular accessibility

- 4.11 For resilience and to maintain business continuity, it is essential to ensure adequate access and egress routes to healthcare facilities are kept open and functional.
- 4.12 Depending on location and likelihood of emergencies, hazards and threats, the following will need to be taken into consideration:
- **Roads:** balance the need for easy access for emergency vehicles against the perceived need for access. Limit the maximum possible approach speeds of vehicles by implementing traffic calming measures such as bends, humps and chicanes and consider the use of barriers as a final line of defence.
 - **Accessibility in adverse weather:** consider the cost benefits of having access to a snow plough, de-icing vehicles or vehicles capable of transporting key personnel in a snowstorm to maintain business continuity at a time when there is increased need for healthcare facilities due to slips, trips, falls, accidents and injury.
 - **Car parking:** careful management of the car park will be required to reduce any risk. Siting car parks in basements beneath tall buildings, where the effects of a flood, fire or a confined explosion would be much greater, will require significant additional structural engineering effort (and hence expense) to ensure that the building would safely withstand the impacts.
 - **Vehicle bomb:** the best defence against such devices is distance; therefore, where such a threat is considered credible, precautions should be designed to maintain a stand-off distance by controlling vehicular approaches.
 - **Loading bays:** these present a particular vulnerability to the structure since trucks need to approach right up to the building to deliver supplies. The risk can be minimised by siting them away from high-occupancy areas such as wards, canteens or sensitive areas such as laboratories. Access to the loading bays should be controlled; where the threat is deemed high enough, barriers covered by a CCTV and intercom arrangement should be considered, to deny entry until the validity of the delivery is assured.



- 4.13 Unexpected changes in risk and threat may mean that additional measures will need to be imposed to control vehicular access. Having a flexible management strategy in place will help to deal with new risks and threats as they become known.
- 4.14 The design team should consider provision of space for eventual introduction of further restrictions on vehicular access, denial of access to certain areas altogether and the introduction of enhanced parking restrictions.

Space for additional facilities

- 4.15 Space may need to be allocated on the proposed site for additional emergency facilities to deal with specific eventualities. Facilities such as chemical, biological, radiological and nuclear (CBRN) decontamination units, temporary water and/or fuel tanks and logistic stockpiles may be included in the project brief, and need space to be allocated to them. If the public parking area is designated for this, an alternative plan will be needed to allow visitors access to the site, and perhaps a shuttle bus-service could be considered.
- 4.16 If an emergency occurs, it may not be possible for waste disposal vehicles to come to site to remove healthcare waste. Most healthcare sites do not have the space to store waste for more than 24 hours. If this happens, for example, at a time of pandemic influenza, clinical/hazardous waste will build up more rapidly. Steps will need to be taken in discussion with NRW and infection prevention and control teams to avoid problems that could result. Consideration should also be given to the build-up of combustible materials which create a fire hazard. See WHTM 07-01:2013 *Safe management of healthcare waste*. See also [paragraphs 5.64–5.67](#).

Control of pedestrians

- 4.17 Within the grounds, hard landscaping features such as footpaths and planted areas can be used to mark areas that are part of the design requirements for resilience. Smooth building lines and well-designed, well-maintained footpaths/grounds will improve pedestrian flow while minimising the effects of weather events.

Pedestrian entrances

- 4.18 Designers should consider:

- limiting the number of entrances into a building or facility to the smallest number commensurate with the anticipated (and desired) flow of patients, staff and visitors;
- including space at the entrance to incorporate an influx of patients/personnel seeking aid or a personnel search facility if required;
- ensuring that access can be further restricted as necessary without excess impact on operational efficiency;



- access control (for example, swipe-card access and other controls), separating staff and visitor entrances and incorporating positive access control on using keys or electronic pass systems;
- allowing space for a decontamination area to be set up to receive contaminated casualties. External or adjacent land – car parks, playing fields, open areas etc – should be considered as potential decontamination locations using tents for cover. The draught lobby space or commercial areas could also be used for this;
- making the entrance robust against potential civil disturbances, if required, by selecting suitable street furniture and landscaping materials to ensure that the opportunity for aggravated disturbance is minimised.

Separation of patient access areas from other parts of healthcare premises

- 4.19 WHTM 05-02:2014 (*Firecode*) *Fire safety in the design of healthcare premises* provides guidance on the separation of patient access areas from areas considered to be a fire hazard or risk and the development of appropriate evacuation strategies. In most healthcare buildings that provide in-patient accommodation, the fire evacuation strategy is based on progressive horizontal evacuation, where people are moved progressively away from a fire through fire-resisting walls. This approach may not be appropriate for non-fire emergencies. Therefore, alternative strategies may need to be developed through the normal user group consultation.
- 4.20 *Extreme Weather Public Health Alerts & Advice for Wales* (PHW 2016) includes the requirement for internal room temperatures to be monitored and to ensure sufficient flexibility of room design and function such that vulnerable patients/people can be relocated to cool areas or zones within facilities when necessary.

High-density sites

- 4.21 In city-centre or other high-density sites, where pressure for space will always be high, designers should consider potentially radical options for reusing space to ensure that the impact of an event is reduced to an acceptable level (for example, adapting office accommodation or non-clinical areas for use as treatment areas). This should be done in consultation with key advisers such as local fire officers and lead officers for emergency preparedness/civil contingencies.

Redundancy

- 4.22 Depending on the risk or threat level, organisations should consider whether any of the site-wide design considerations listed above should exist in duplicate or have an alternative. For example, access roads and entrances from the public highway may need an additional temporary route.

Protective security

- 4.23 Security covers many areas, most of which are described as robustness measures throughout this document. Additionally, the hazard and threat assessment may indicate that the areas described below are also examined.



- 4.24 Perimeter controls, such as fencing, while not popular, do offer the ability to control foot and vehicle traffic and enable accurate surveillance by channelling visitors into areas covered by CCTV and making a suspicious intent more obvious earlier. This can improve the general security of the facility as well as improving resilience by reducing the likelihood of a threat materialising.
- 4.25 When considering general security and crime prevention, see also *Secured by design:hospital* (Association of Chief Police Officers 2005) for additional guidance.

Lockdown

- 4.26 The need to seal off a facility from the outside or to isolate it internally may arise as a result of an intrusion, civil disturbance, terrorist attack or outbreak of an infectious disease. Selection of appropriate doors, barriers and locks as well as the use of electronic locks and identity/authority verification systems such as card readers, PIN codes and biometrics can then be used to enforce a policy. Appropriate signage and wayfinding strategies may also be used to support the enforcement of lockdown *NHS Wales emergency planning guidance. Planning for lockdown of NHS facilities* (Welsh Government 2015b)
- 4.27 Lockdown may be imposed from either an internal or an external authority, and may have as its role either the prevention of entry or the prevention of exit. The precise form the lockdown takes will depend on a number of variables, including:
- duration,
 - reason,
 - direction of movement to be controlled,
 - local circumstances,
 - availability of personnel to administer,
 - suitability of facility to be locked down,
 - physical environment and orientation of the site,
 - lockdown zoning.
- 4.28 Design teams should consider the necessary architectural elements which make the implementation of lockdown easier to perform – in essence, those elements which define discrete zones within a facility and which limit access to those zones, with particular reference to external interfaces and interfaces to areas of high sensitivity or threat potential. This should be carried out in consultation with the lead officers for emergency preparedness/civil contingencies.



- 4.29 With regard to the measures for managing threats, project teams should read the *HMG security policy framework* (Cabinet Office 2013) and bear in mind the advice in *Secured by design* (Association of Chief Police Officers 2005), which defines a series of baseline measures for security-conscious design.

Detection systems

- 4.30 There are a number of electronic options to assist security staff in detecting intruders and managing incidents. These may include:
- intruder detection systems (burglar alarms), which provide an excellent method of backing up an access control system by guarding entrances that are not normally in use (fire escape doors, windows etc); and
 - CCTV, which allows more efficient deployment of security manpower and allows verification of alarm incidents remotely. CCTV may prove particularly useful in isolation units as it will allow staff to maintain protection around an area without needing to enter it. CCTV would also assist where buildings have a period of low occupancy or use.
- 4.31 In a new project, access control, intruder detection, CCTV (high definition and low light) and audio capability could be integrated into a security management system.

Note

See also the Centre for the Protection of National Infrastructure's website (www.cpni.gov.uk).

Screening

- 4.32 Where there is a particularly high risk to a facility, permanent installation of screening equipment to examine incoming goods and mail may be indicated. Even where it is not, it may be prudent to allow space and services for its installation in the future.

Mail rooms

- 4.33 Mail rooms should be sited to minimise the distance that unchecked mail has to travel through a building. Rooms should have at least one outside wall to allow a blast to vent, and should be robust enough not to pose a threat to the remainder of the structure.

Personnel screening

- 4.34 The precise screening measures required will depend on the risk assessment and may include the provision of security staff at entry and exit points on a part- or full-time basis.
- 4.35 Additional detection/search facilities may be required in high-risk areas at times of heightened alert. Where required, these should take place outside of a protected space. Consideration should be given to the space required not only to carry out the searches but also for queues of waiting people. If the threat is one of explosives, physical protection of the rest of the facility from the screening area should be addressed. Thought should also be given to how persons screened – but found unsuitable for access – should be directed away from site in a secure manner.



- 4.36 It should be noted that any imposition of an airport-style regime would severely impact on the functionality of the building and how this eases or impedes the flow of people in and out of any facility. Each line would require at least three persons to administer it – one screening, one searching and one keeping oversight of all activity.

Designing for resilience to the impacts of climate change

Introduction

- 4.37 The built environment's response to climate change is organised around two main types of intervention:
- adaptation – the need for climate resilience in building type, form and layout needs to be planned and designed appropriately to meet projected healthcare demands and to protect the health of the patients, staff and visitors within these buildings (paragraphs 4.38–4.63 focus on this type of intervention);
 - mitigation – the amount of energy generated (carbon footprint) which contributes to climate change, requiring buildings to be energy-efficient in design, location and service function.
- 4.38 The impact of climate change on a building will depend on how early and well organisations have planned for, and adapted their facilities to cope with, the impacts of climate change. For example, health impacts during heatwaves can be reduced by the effective planning and provision of appropriate temperature controls such as using green roofs and planting trees and zoning of healthcare buildings. The earlier adaptation measures are introduced, the lower the overall financial impact is likely to be on an organisation in the longer term and the better equipped they will be to deal with the predicted changes in climatic conditions.



Summary of specific responsibilities related to climate change

- *The Climate Change Act 2008* requires a quinquennial CCRA – first published in 2012 – to identify the risks and opportunities related to climate change (the most recent being published by the Committee on Climate Change 2016). The Act also sets a framework for dealing with the top risks identified in the CCRA through the UK NAP (HM Government 2013).
- The UK NAP (also a requirement of the *Climate Change Act 2008*) provides a framework for action. Adaptation planning is an opportunity to ensure a cohesive approach to current and future planning. The process of developing these plans should integrate with the development and refinement of emergency preparedness and BCPs to prepare for the current and future impacts of climate change.
- The *Wales Flood Response Framework* (Welsh Government 2016) sets out the Welsh Government’s strategic approach against flooding and is intended for use by all those involved in planning for and responding to flooding from the sea, rivers, surface water, groundwater and reservoirs.
- The Natural Hazards Partnership (NHP) (<https://www.gov.uk/government/policies/improving-the-uks-ability-to-absorb-respond-to-and-recover-from-emergencies>) brings together expertise from across the UK’s leading public sector agencies with the aim of drawing on scientific advice in the preparation, response and review of natural hazards. Partners include the Welsh Government. Among its activities, the NHP publishes a daily hazard summary assessment, which is issued to stakeholders and currently covers some of the following hazards:
 - flooding;
 - geological hazards, such as landslides;
 - weather;
 - wildfires;
 - windstorms.

4.39 Generic adaptation measures appropriate for healthcare infrastructure could include the following:

- The increased use of SuDS to provide a more sustainable approach to draining surface water (for example, a forecourt made from permeable material will allow water to drain away easily). Drainage systems need to be able to cope with the predicted increased frequency of heavy bursts of rainfall.
- Raising flooring in new-build properties to guard against flooding due to increased heavy downpours. Repositioning of power points further up the wall to guard against flood damage.



- Well-designed green spaces to help reduce the urban heat island effect, protect against flooding, promote healthy lifestyles and provide health co-benefits. Plants can be selected for resistance to drought. Trees can provide natural shading and their transpiration helps to mitigate the urban heat island effect.
- Double-glazed windows provide both insulation and natural ventilation, while screens protect against biting insects and vector-borne diseases.
- Roofs could be “green” (to help with the urban heat island effect, reduce water run-off and help biodiversity) or “white” (to reflect heat from the sun) or fitted with solar panels or micro wind turbines to generate electricity.

Note

Load-bearing properties of the roof will need to be carefully calculated to safeguard against potential overloading at times of heavy or prolonged rainfall when the green roof will absorb and retain moisture.

- Innovative building designs will be needed to ensure buildings remain resilient and fit for purpose over time.
- Heat pumps are able to extract heat from the air, ground or water sources (such as rivers or lakes) within the curtilage of a healthcare building and are an energy-efficient way to replace or supplement heating provided by fossil fuels or conventional electric heating methods. They can also be reversed to extract heat from the building when internal cooling is required.
- Road surfaces can be made from materials that are able to cope with hotter temperatures and more intense rainfall.

Floods

4.40 This document incorporates an increased focus on flood risk because the CCRA shows this is one of the largest increasing risks for the UK. *Report on the lessons learned from the summer 2007 flooding experiences from an estates and facilities perspective* (DH 2007) demonstrates the importance of being resilient to floods and the consequences of not being resilient.

4.41 Developments should be located outside areas of flood risk. Where this is not feasible the *National planning policy framework for England and planning practice guidance* (DCLG) website contains useful guidance (<http://planningguidance.planningportal.gov.uk>). Important flood risk factors to consider which will influence the design include:

- flood mechanisms (how the site would flood);
- predicted flood level;
- duration;



- frequency;
- velocity of flood water;
- depth; and
- amount of warning time before flooding.

4.42 Where assessment shows that there are no suitable alternative sites available in lower flood-risk areas and development is required, a detailed site-specific flood risk assessment (FRA) should be carried out.

4.43 A range of construction measures can be used to reduce the flooding risk at a site:

- Flood avoidance: where it is not possible to locate a building in an area of lower flood risk, constructing a building and its surrounds (at site level) to avoid it being flooded (for example, by raising it above flood level).
- Flood resistance: constructing a building to prevent floodwater entering the building and damaging its fabric.
- Flood resilience: constructing a building to reduce the impact of floodwater entering the building (so that no permanent damage is caused, structural integrity is maintained and drying and cleaning are facilitated).
- Flood repairable: constructing a building so that elements that are damaged by floodwater can be easily repaired or replaced.

4.44 Residential areas may contain a variety of land uses, including dwellings, vehicle and pedestrian access, parking areas, shops, schools, healthcare and other community facilities. Layout should be designed so that the most vulnerable uses are restricted to higher ground at lower risk of flooding, with more flood-compatible development (parking, open space etc) in the highest-risk areas.

4.45 In designing site layout, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide important flood conveyance and storage as well as providing connected green spaces with consequent social and environmental benefits. This green infrastructure has the potential to raise the profile and profitability of a development and contribute to other sustainability objectives.

4.46 Landscaping of public access areas subject to flooding should allow for easy access to higher land as flood waters rise and should avoid local features that could become isolated islands. Fences, hedges and walls should be designed and implemented so that they do not cause obstructions to escape routes.



- 4.47 Any essential structures, such as shelters and seats, should be designed to be flood resilient and firmly attached to the ground. The planning permission should make provision for future management of such areas through planning conditions or Section 106 agreements, with particular regard to safety signing, permitted and prohibited structures and the management of vegetation.
- 4.48 Buildings should be designed to withstand the effects of flooding. In areas of high velocity water, buildings should be structurally designed to withstand the expected water pressures, potential debris impacts, erosion and undercutting that may occur during a flood event. Particular care should be taken in the design of any building located in a rapid inundation zone. This should also apply to any architectural features within the grounds.
- 4.49 The final step in the flood risk management hierarchy is to mitigate through building design. This represents the least-preferred option for new development as although buildings can be designed for reducing the impacts of flooding, hazards still remain, particularly for access and utility supply (see also *Improving the flood performance of new buildings: flood resilient construction* (DCLG 2007)).

Flood risk assessment (FRA) and consequence reports

- 4.50 FRA and consequence reports should be commissioned to address local authority planning requirements and the need to understand the nature of potential flood risks. Reports should include consideration of the likely effects of climate change (such as increased rainfall). For new developments, areas of permeable and impermeable ground cover should be pre-calculated. All possible relevant flood sources should be covered, including rivers, coastal inundation, surface water, groundwater, sewers and reservoir failure.
- 4.51 Consultation should be undertaken with regulators, including local authority drainage engineers where appropriate. Risk assessment and consequence reports can be used to meet the requirements of the following guidance by DCLG, which is also relevant to Wales:
- *National planning policy framework for England and planning practice guidance* (<http://planningguidance.planningportal.gov.uk>), when considering a planning application or for a healthcare provider to influence an emerging local plan;
 - *BREEAM New Construction 2014: Non-Domestic Buildings (Wales). Technical manual SD5076:50 – 2014* (BRE 2014). Particularly the credit issue Pol 03: Surface Water Run Off.
- 4.52 For properties located close to, or within, an EA fluvial or tidal flood risk zone, it is recommended that reports include NRW data on flood levels; a data request will provide modelled flood elevations.



4.53 Reports should clearly identify who or what is at risk and may include solutions to limit such risk. They are based on factual interpretation, addressing areas of concern and assessing flood risks to the site from rivers,run-off and groundwater, and also consider potential issues from the regulatory perspective. They can include traffic-light risk ratings and preliminary risk assessment in line with best practice and regulatory guidance such as the DCLG’s web pages, *National planning policy framework for England and planning practice guidance* (<http://planningguidance.planningportal.gov.uk>).

4.54 Reports should be obtained:

- for the clarification of risk for insurance purposes;
- when validating planning requirements when submitting a planning application;
- to meet planning conditions;
- for land and property purchase;
- for the sale or divestment of a site;
- for due diligence purposes;
- as required for external organisations when new facilities are procured from non-NHS organisations (for example, the requirement of a bank or other funding institution financing the project);
- as part of the business risk assessment.

4.55 Reports should reference:

- customer-supplied information (for example, site location plans, proposed development plans, walkover surveys and recent site photographs);
- the local strategic FRA;
- preliminary risk assessment of flood to the site from all potential sources;
- assessment of flood risks off-site due to new developments and the latest UK environmental datasets:
 - flood risks from rivers, surface water run-off and groundwater;
 - sewer flood risk if the site is in a built-in area;
 - historic flood maps;



- solid and drift geology;
- rainfall assessment.

4.56 When commissioning FRA and consequence reports from specialists, it is prudent and cost-effective to consider obtaining additional reports to assess other environmental matters such as SuDS (identifying site constraints and potential sustainable drainage solutions including run-off and storage volumes), geo-hazards and contaminated land (which may include landfill sites and burial grounds).

Note
The *Floods and Water Management Act 2010* establishes a Sustainable Drainage Systems Approving Body in unitary or county councils. This body must approve drainage systems in new developments and redevelopments before construction begins.

Heatwave risks/drought: specific adaptation measures

4.57 Extended periods of dry weather leading to drought could:

- cause increased levels of dust, haze and fog;
- lead to land instability; and
- cause wildfires, which can culminate in one or more of the following:
 - loss or significant reduction in water supplies;
 - slowed rate of sewage flow through the system, leading to public health concerns;
 - increased risk of vermin above ground;
 - reduction in water quality;
 - loss or reduction of capacity in the electrical supply network;
 - potential impact/closure of primary transport routes;
 - possible closure of some businesses;
 - increased demand for water supplies from all infrastructure sectors including health, agriculture, energy and emergency services;
 - increased demand for emergency power;
 - increased demand for health and emergency services.



The dynamics and implications on the built environment and its resilience are illustrated in research by Short et al (2012). The challenge of reducing carbon emissions and energy demand is amplified by the health implications of a changing climate.

The 2003 heatwave led to 15,000 excess deaths in Northern France. The UK heatwave of June/July 2006 is thought to have led to an increase in deaths over baseline mortality of 4%, and there were approximately 300 excess summer deaths after the 2009 heatwave between 30 June and 2 July.

Individuals sensitive to high temperatures are likely to be present at all times in hospitals, including those with compromised thermoregulatory systems (older people, the chronically and severely ill and those on certain medications that impair perspiration) as well as those who cannot take action in the face of high temperatures (small children, those patients who are confined to bed and patients with mental health problems). However, very few existing buildings within the NHS estate were designed to be air-conditioned; indeed, many are poorly insulated and often over-glazed, leading to increased risk of summertime overheating, even in recently completed buildings.

The paper concludes that refurbishment, in particular to curb the heat lost through uncontrolled leakage of ventilation air from the building, could reduce energy demands and maintain or even improve the internal environment in the current climate. The five refurbishment options researched also offer the opportunity to increase the resilience of the building in a warming climate while saving energy. It concludes that relatively modest interventions could achieve substantial savings while achieving future resilience.

Excessive cold – snow and ice

4.58 *Extreme weather public health alerts and advice for Wales* (Public Health Wales 2015) aims to protect individuals and communities from the effects of cold weather and to encourage community resilience.

4.59 Coordinated multi-agency long-term planning and commissioning for cold weather is essential to:

- protect people and infrastructure from the effects of cold weather and thus reduce excess winter illness and death and the burden on health and social care sectors;
- support improved building design and increased energy efficiency which can improve and protect health (thereby potentially reducing pressure on health provision) and reduce carbon emissions;
- improve insulation properties of buildings in order to retain heat and minimise energy usage (note: insulation values need to be evaluated along with temperature controls).



Case study: Winter freeze/thaw, December 2010

This case study details a review undertaken by the Sustainable Development and Engineering Branch of the Health Estates Investment Group (Northern Ireland) into the resilience of the Health and Social Care estate in Northern Ireland subsequent to the extreme cold weather events of December 2010 and thaw of January 2011.

The main problems encountered by the trusts during the extreme cold weather event of December 2010 and January 2011 included:

- Buildings were designed to a standard and performed to that standard, but were unable to cope with prolonged temperatures of -10°C .
- Failure of frost coils in air handling units (AHUs). The short-term solution was to divert warm plantroom air into the AHU inlets. The reduction of air flow, where possible, also helped.
- An excess of natural ventilation in newer buildings gave problems in lifting air temperatures.
- In fully air-conditioned buildings, the AHUs were the only source of heating. This gave rise to a single point of failure.
- Pipes that were stressed by being frozen burst under pressure.
- Reverse osmosis plant in some instances could not operate due to being in an unheated space.
- In multi-storey facilities, loss of water pressure caused problems.
- Contingency plans did not cover a complete loss of both electricity and water supply.
- Lack of a dedicated point of contact within Northern Ireland Water (the water supplier).
- Lack of a formal structure for emergency contacts with Northern Ireland Water.

Wildfires

4.60 The CCRA in 2012 (Committee on Climate Change) identified an increase in the incidence of wildfires as an emerging risk associated with climate change. Severe wildfire is included in the *National risk register of civil emergencies* (Cabinet Office 2015). It is anticipated that LRFs will review and consider the severe wildfire risks, as will the fire and rescue service, through their integrated risk management plan process. National Resources Wales and the UK Forestry Standard (Forestry Commission 2011) should be consulted as part of the contingency planning for any development whose location may be prone to such risks.



Windstorms (storms and gales)

4.61 Severe windstorms around the UK have become more frequent in the past few decades. The vulnerability of healthcare buildings in windstorms is a function of the strength of the building envelope components and their connections. Designers should use wind damage and impact prediction models to take account of the increase in the frequency of windstorms and in average wind speeds.

Case study

In 2013 a storm brought disruption to the whole of South Yorkshire, and gale-force conditions cut off the power supply to Barnsley District General Hospital, which was obliged to cancel out-patient appointments while operating on emergency standby generators. The hospital issued a statement to reassure people that patients in the hospital were safe. Power was recovered and normal service resumed later that same day. The incident demonstrates the need to maintain business continuity through implementation of contingency plans and concomitantly the importance of good strategic communications – reassuring the public and mitigating risk.

Water resources

4.62 Increasing pressure on water resources is a growing risk. Buildings will need to become more water-efficient due to the predicted changes in water availability. Climate change and population growth may ultimately lead to less reliable supply conditions or restrictions on abstraction licences for those healthcare organisations with their own borehole supplies.

4.63 Adaptation and mitigation measures would include:

- close cooperation and communication with local water companies to conserve water;
- water conservation measures to collect and store water for non-patient use;
- installing water monitoring systems and water management plans for early detection and repair of leaks;
- checking and regular monitoring of water-pipe capacity and capability at planning/ design stage and regularly thereafter.

See also HTM 07-04:2012 *Water management and water efficiency*.



Blast-resistant building design considerations

4.64 If a risk assessment identifies a high likelihood of threat from terrorism or a bomb, the following will need to be considered to maintain the structural design of buildings to resist blast effects caused by explosions:

- Use a framed construction in either structural steel or reinforced concrete that has the “degree of robustness” required by the relevant British Standards, whatever the number of storeys (that is, all buildings less than five storeys high should be designed as a five-storey building for robustness only).
- Provide “protected spaces” (previously known as bomb-shelter areas). This may be achieved by careful planning of the internal building (not necessarily reinforced concrete) or by the provision of a robust basement construction. In a healthcare environment these areas may need to be extended to wards if patients cannot be evacuated.
- Have ground- and first-floor slabs constructed of in-situ reinforced concrete, with slabs designed as suspended so that they can withstand the removal of one or more structural columns beneath them.
- Have floor slabs tied down to their structural supports to allow for the load reversal that occurs in an upward blast.
- Have a roof slab that is of similar construction to that of a typical floor.
- Have a cladding system that will not become an additional shrapnel hazard if separated from its supports and that can be repaired without removing undamaged panels.

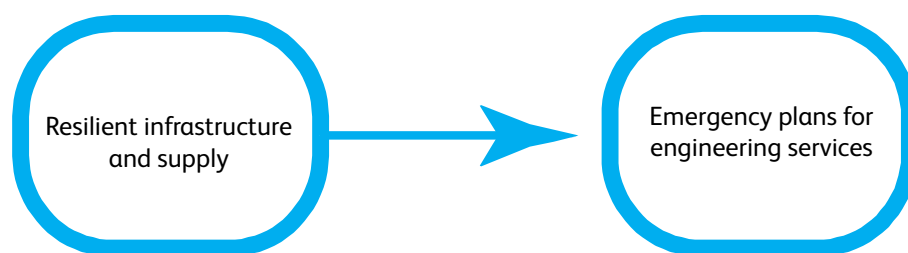
Access to documentation

4.65 During an extreme event, the emergency services may request to see up-to-date electronic and paper copies of site plans, engineering services diagrams and other relevant documents. Senior managers should ensure that these are readily available and accessible.

5

Chapter 5

Resilience of building services engineering



Resilient infrastructure and supply

- 5.1 Many medical technologies and modern communications are reliant on a reliable energy source. Therefore, in planning and designing any healthcare facility, the energy supply not only has to be adequate, but also robust and resilient. Single points of failure should be eliminated.
- 5.2 The location of hospitals requires careful consideration to ensure that they are built within low-risk areas so that disruption of infrastructure, including energy supplies, is minimised or prevented (see [Chapter 4](#)). Once operational, the systems and equipment providing the source of energy require regular maintenance with the prioritisation of the replacement of old equipment and the use of new and emerging technologies to mitigate the effects of age-related failure of systems and equipment (Klinger *et al* 2014).

Electricity

- 5.3 Electricity is probably the most vital of all infrastructure services; without it, most of the other services will not function. The entire electricity distribution system, both within the facility and the external provision from the supply network, should therefore be designed to be as resilient as possible. This can be achieved by applying the principles of robustness, redundancy and reconfigurability to the system as the design progresses in accordance with **HTM 06-01 Electrical services: supply and distribution*. See also *Report on the lessons learned from the summer 2007 flooding experiences from an estates and facilities perspective* (DH 2007).

Mains electricity supplies

- 5.4 Designers should consider how a secure electricity supply can be ensured. Priority allocation of the site should be carried out with the network supplier for the site. Where practical, consideration should be given to having two or more sources of supply from the supplier. A supply at high voltage (HV) from one or more primary network substations may have a higher initial cost, but will be more resilient against load-shedding in times of high demand or extreme events.
- 5.5 It is important that NHS Wales-funded providers establish a formal working relationship with the electricity supplier. This may mean registering as a priority user. Normally this will be with a nominated client manager.



Robustness

5.6 The distribution system, including all of the non-electrical components such as substation buildings, emergency fuel supplies, cable ducts and other containment, should be robust enough to survive design hazards and threats. Where facilities are not duplicated, or where potential for a single point of failure exists (for example, where the standby generator is in the same building as the intake substation), robustness is doubly vital as the last line of defence. Consideration should be given to designing such facilities as protected spaces. Action should also be taken to eliminate the single point of failure as a matter of good practice and to ensure maximum robustness.

Redundancy

5.7 The electricity distribution system within the facility is best protected by having multiple sources of supply at all levels. Normal electrical system design, including the requirements and recommendations made in *HTM 06-01 *Electrical services: supply and distribution*, recommends the degree of redundancy in an electrical system which may need to be enhanced once credible threats are included in the risk management process.

Control

5.8 Building management (or other control) systems need to give an indication as to the state of the electricity supply. When the mains supply fails or is subjected to cyber attack, actions need to be triggered such as:

- the preparation of maintenance responses;
- automated responses such as the shutting down of a computer server on activation of a UPS;
- isolation of non-essential loads;
- the ability to initiate manual overrides.

Reconfigurability

5.9 The ability to reconfigure a faulty or failed electricity supply system, or to reconfigure it should demand increase, can be designed into a system at the outset:

- Ring circuits rather than radial feeders provide two possible sources of supply and therefore provide a degree of resilience against damage and failure. Critical ring mains in HV networks can be made “closed” rather than “open” for maximum security of supply, albeit at greater expense, provided that adequate protection arrangements are installed.
- Interconnectors between node points on the network can be positioned to increase options for supply and to allow for bypass of damaged areas or failed components.



- Spare capacity in switchrooms and substations is essential to allow on-site engineering staff options to re-establish supplies after a failure. If access to the busbar is available (for example, by installing sockets and suitable interlock systems), a portable generator can be coupled to the system to replace a failed mains supply, or a new cable can be run out to a temporary facility. When refurbishment projects are being designed in existing facilities, it is good engineering practice to ensure spare capacity remains and, if necessary, install new switchgear.
- Sensing and control: developments in building management and automatic control systems are making it increasingly possible to design-in the ability to automatically sense failures and reconfigure the network accordingly. Business-critical facilities should consider using this technology.

Standby generation

- 5.10 Generators will provide an additional level of redundancy for essential loads. *HTM 06-01 *Electrical services: supply and distribution* gives guidance on the number of generators that may be appropriate; the hazards and threats identified in the design brief will indicate whether it is appropriate to site standby generation in the same physical location as the power supply it replaces.
- 5.11 Standby generators should not be sited in basement areas or low-lying areas that are at risk of flooding.
- 5.12 Standby generators should be subjected to regular full-load testing. This will also ensure that the automated changeover from the mains supply to the standby generator functions correctly. Full-load testing can be achieved using load banks if required, but this on its own will not replicate the correct operation at a time of full mains failure.

Combined heat and power (CHP)

- 5.13 Where a CHP system is being considered, there is scope to consider this as a secondary form of standby generation provided that its other operating capabilities will be met. If the CHP system is provided on a leased arrangement, the maintenance and emergency repair response times should be considered and stated as contractual requirements, as should regular testing and availability criteria.

Uninterruptible power supplies (UPS)

- 5.14 Critical loads may require a UPS (static or rotary) to be installed. Currently, battery technology and space requirements generally limit these devices to providing power for a short period or to a controlled shutdown rather than to continue operating indefinitely. An exception to this is where a UPS is used to cover the break in supply while a standby generator starts or to support critical care and essential supplies while alternative supplies are made available.
- 5.15 For more information regarding management and operation of electrical systems, see the HTM 06 series of guidance, in particular HTM 06-02:2006 *Electrical safety guidance for low voltage systems* and HTM 06-03:2006 *Electrical safety guidance for high voltage systems*.



Lighting

- 5.16 Consideration should be given to robust exterior lighting systems for all public access. These systems need to be suitable for extreme weather events (for example, high winds and flooding). External lighting may need to be fixed to the building structure in key locations.
- 5.17 LED lighting technology is increasingly being used in healthcare settings, principally because of their efficiency and low power consumption. It is possible to supply LED lighting via a dc power source so in an extreme power loss situation it is possible to supply LED lighting systems via battery banks.

Water

- 5.18 The continued availability of clean and safe hot and cold water supply is vital for healthcare premises, which are dependent on water to maintain hygiene, hydration and a comfortable environment for patients and staff.
- 5.19 Interruptions in mains water supply – whether planned or unplanned (such as a burst water main, low mains pressure, electrical supply failure, pump failure or concerns relating to water quality) – can disrupt healthcare activities. The design of systems must ensure that sufficient reserve water storage is available to minimise the consequence of disruption, while at the same time ensuring an adequate turnover of water to prevent stagnation in storage vessels and distribution systems.
- 5.20 Mitigating the risk of having a single source of supply should be considered, and the possibility of acquiring a second source should be investigated. This could take the form of a second mains water supply, fed from a separate network to reduce reliance on a single network, or alternatively the utilisation of a private borehole or other alternative source. Should the private borehole be identified as being specifically for emergencies, obtaining or retaining an abstraction licence may be easier.

Note

It is important that NHS Wales-funded providers establish a formal working relationship with the water supplier. This may mean registering as a priority user. Normally this will be with a nominated client manager. The two parties should work together to establish, as a minimum:

- potential mains water supply risks and how these risks can be mitigated;
- provision of water supply in the event of mains water failure (for example, provision of water tankers/ bowsers, bulk bottled water);
- leakage prevention strategies to prevent contamination of the water distribution system within the healthcare provider's estate from lack of integrity of the on-site potable water distribution system.

- 5.21 Designers should consider not only how a secure supply can be guaranteed but also how its potable quality can be assured. Client organisations should advise the designer on whether the risk of using non-potable supplies for certain tasks (such as laundry services and cleaning) is acceptable.



- 5.22 Where potable water is required from secondary or alternative sources, on-site water treatment options (see [paragraphs 5.26–5.31](#)) can help mitigate the loss of mains potable water.
- 5.23 The designer should consider the integration of bowser/tanker connections so that tankered water supplies can be efficiently discharged into the healthcare building's water storage system. The local water supplier should be able to assist in the provision of tankered water supplies and this will help ensure that the quality of the water delivered in this manner is through an appropriate quality control system.
- 5.24 WHTM 04-01:2016 *Safe water in healthcare premises* give comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design applications, maintenance and operation of hot and cold water supply, storage and distribution systems in all types of healthcare premises. It is equally applicable to both new and existing sites.
- 5.25 With respect to risks associated with flood and fire, designers should also refer to:
- Chapter 8 on flood risk in HTM 07-04:2012 *Water management and water efficiency*;
 - *Report on the lessons learned from the summer 2007 flooding experiences from an estates and facilities perspective* (DH 2007);
 - WHTM 05-02:2014 (Firecode) *Fire safety in the design of healthcare premises* (so that requirements for fire-fighting are also met).

Water treatment

- 5.26 Where a need for on-site water treatment is identified, the required final water quality will determine the treatment required.
- 5.27 Where the healthcare provider has its own on-site borehole, if this is already being used for the provision of potable water, it should already be registered with the local authority and compliant with the *Private Water Supplies (Wales) Regulations 2010*. Depending on the borehole's characteristics, filtration and disinfection may be required, but in most cases the borehole supply is solely subjected to disinfection.
- 5.28 Where the on-site borehole is suspected of being contaminated by floodwater or other contaminants, the borehole should be removed from service and expert advice sought before it is returned to service.
- 5.29 Where it is identified that treatment of alternative water sources is required, packaged potable water treatment plants are available. These are likely to be either reverse osmosis plants or filtration plants. Both require a disinfection process before the water enters the healthcare building's water distribution system and will need to be compliant with the *Private Water Supplies (Wales) Regulations 2010*.



- 5.30 Disinfection may take the form of chlorine-based chemical disinfection, ozone disinfection (via an ozone generator) or ultraviolet disinfection using specialist lamps. As properly controlled chemical dosing with chlorine-based compounds can maintain a residual disinfectant level in the treated water, it is the preferred solution.

Note
There may be the need to consider remineralisation following treatment. All chemicals used in the disinfection process should be BS/EN accredited.

- 5.31 For further guidance on water treatment, see the WHTM 04-01:2016 *Safe water in healthcare premises* series.

Bulk stocks

- 5.32 The quantity of water that is held in storage on-site should be decided. The key factor affecting the decision will be the anticipated length of time that the mains water supply may fail and the time that would be required to establish an alternative (for example bowser/tanker delivery) supply route. This should also be balanced against the costs associated with maintaining the stock in a potable condition.
- 5.33 When bulk supply of bottled water is carried out, the pallets of bottled water should be suitably stored to prevent external contamination of the bottles. They should also be stored at room temperature and away from direct sunlight.
- 5.34 A suitable arrangement for the supply of bottled water should be in place with the healthcare provider's water supplier or other suitable organisation that is able to respond accordingly.

Sewage

- 5.35 Although certain healthcare premises may have their own sewage treatment facilities, most will dispose of their sewage and trade effluent through the municipal sewerage network. However there are instances where this normally reliable disposal route may break down. A combination of aging sewer networks and the restriction of sewers due to the build-up of fat deposits and other media can lead to capacity problems within the network. In certain instances this will manifest itself as a complete blockage of the network.
- 5.36 Owing to the widespread use of macerators to dispose of bedpan waste and food waste, this effect can also occur within a healthcare organisation's own sewage disposal network if care is not exercised in the correct risk assessment, selection and monitoring of macerators and the on-site sewage disposal network. Additionally, *The Environment (Wales) Act 2016* will prohibit the disposal of food waste to drain from non-domestic premises. This is to ensure that food waste is available for more beneficial treatment and use as a resource rather than disposal, and to reduce the risk of blockages in the sewer network.



- 5.37 The lack of capacity within the sewer network can be exacerbated during times of heavy or prolonged rainfall, a particular concern during extreme weather events, leading to the backing up of the sewage within the network and/or surface water flooding. Both can result in flooding of premises or land with water contaminated to a greater or lesser degree with sewage effluent.
- 5.38 Consideration of the age and condition of the local sewage and surface water disposal networks should form part of the decision-making process when:
- selecting a site for a new facility;
 - planning construction of additional buildings on an existing site.
- 5.39 This is particularly pertinent for facilities built in flood-prone areas, where the risk of sewage inundation as well as flooding should be assessed.

Note

As with water, it is important that NHS Wales-funded providers establish a formal working relationship with the water company that provides their sewage and trade effluent services. This will normally be with a nominated client manager and may be the same person/team providing the point of contact for water services. The two parties should work together to establish, as a minimum:

- potential sewage and trade effluent disposal risks and how these risks can be mitigated or removed;
 - provision of waste water tinkering services or temporary sewage treatment facilities in the event of sewer collapse, sewerage system failure etc;
 - remediation services to assist with promptly returning services to normal following contamination due to sewage or sewage-contaminated flood water.
- 5.40 The loss of the ability to dispose of sewage and trade effluent is a critical infrastructure vulnerability, and due attention should be paid to close liaison with local providers at the design stage to ensure that the relevant local sewerage infrastructure is fully understood in terms of its resilience and reliability. As part of risk mitigation, NHS Wales-funded providers may need to consider provision of alternative disposal facilities, perhaps at a far lower flow rate, to allow continued operation of at least part of the facility under condition of failed sewerage arrangements.
- 5.41 Healthcare organisations that have their own on-site sewage treatment facilities should ensure they have robust plans in place that outline how they will continue to ensure the safe treatment and disposal of sewage during adverse conditions, including returning the treatment facility to correct operation after inundation during flooding events.



5.42 Water UK's (2014) National guidance for healthcare waste water discharges strongly recommends that NHS Wales-funded providers prepare an emergency plan that includes:

- spillages;
- loss of water supply; and
- drainage plans on which drains are suitably marked (for example, "red for foul water sewer" and "blue for surface water sewer").

Fuel

5.43 Fuels should be selected to ensure continuity of supply as well as to satisfy economic and environmental concerns. Primary and secondary fuel arrangements (for example natural gas/diesel dual-fuel options for boilers) are necessary to reduce reliance on sole suppliers and to improve resilience of the supply chain in the event of disruption. Prior engagement and communication with the supplier will:

- better ensure supply in case of emergency; and
- reduce the need for high volume local storage (which mitigates possible theft, contamination and degradation).

5.44 Bulk stocks of fuel should be held to span gaps in supply, but these bulk stocks may also present an attractive target to potential thieves or attackers and should be physically protected. Redundancy can be achieved by ensuring that a number of smaller tanks are held in more than one location, but the fuel, generator and mains transformer should not be aggregated into the same space. Security is important, including the use of lock and key.

5.45 Piped supplies of gas should be discussed with the regional gas transporter to ensure that they are noted as "priority user" and will be maintained/restored as priorities in the event of network difficulties.

5.46 Where off-site fuel storage is considered (oil, solid fuel etc), plans should be made for alternative routes of access in case of blocked roads.

Critical cooling

5.47 Cooling is a particular concern during periods of high temperature. A number of areas and equipment within healthcare facilities have a critical requirement for cooling. These include drug and blood banks, mortuaries, food and prepared meal stores, critical care areas, theatres and diagnostic imaging equipment. Related facilities include business-critical server data centres and high-powered diagnostic equipment.

5.48 In addition to ensuring that the cooling systems have adequate arrangements to power them, adequate redundancy within the system should be provided. This could be achieved by installing a common type of plant across a site to enable cannibalisation of equipment if required.



5.49 Monitoring systems to provide warning of cooling or power failures should be provided, and arrangements or plans made such as:

- data centres being able to hand over to a third party's backup facility;
- high-priority items such as drugs and blood stocks being moved to other temperature-controlled stores;
- letting enabling contracts for the provision of temporary facilities such as refrigerated ISO containers (that is, shipping containers compliant with ISO standards);
- provision of temporary refrigeration units (if refrigerated mortuary facilities are required).

Piped medical gases

5.50 Healthcare facilities that have a significant requirement for medical gases may consider the benefits of providing a vacuum-insulated evaporator (VIE) and a piped distribution system rather than individual bottles an economically attractive option. In such circumstances, the following factors should also be considered alongside the guidance given in HTM 02-01:2006 Medical gas pipeline systems:

- A single VIE for each nature of gas presents a vulnerability to interruption of supply. Provision of two smaller (and physically separated) tanks may not be as economic but will improve resilience with respect to supply chain and deliveries. Monitoring of stock levels within the storage vessels via telemetry to the supplier will also provide additional resilience in supply chain management.
- Regardless of the storage method selected, cylinder storage facilities should be available as a last resort, since the supply of these can be assured from a number of sources (see [paragraphs 5.53–5.54](#)).
- The location of storage tanks should be very carefully considered as they represent a significant hazard in their own right, regardless of any additional threats. The tanks should have good physical protection from unauthorised access and be sited away from high-occupancy areas. Where space considerations prevent a reasonable separation, a protective wall or bund should be considered.
- The engineering infrastructure to generate medical air and vacuum should be as resilient as the supply of other gases. Compressors and vacuum pumps require a source of electrical power to operate, and standby vacuum devices that operate on the venturi principle need a working supply of medical air.

5.51 Additionally, the piped medical gas distribution systems should include features to prevent gases such as oxygen contributing to a fire or explosion in the event that they become damaged (for example, numerous and easily accessible isolation valves should be provided).



5.52 NHS Wales-funded providers should ensure that continuous access to reliable oxygen supplies (be they via bulk storage systems or individual cylinder provision) is available at all times. This is particularly pertinent during the winter period when pressures on the healthcare system may coincide with extreme wintry weather and associated logistics issues.

Cylinder gases

5.53 Healthcare facilities will need to ensure safe and secure storage for bottled and cylinder gases. In the event of a fire, this can lead to an exclusion zone being set up around the site by the fire and rescue service. This can seriously disrupt services and access, and should be taken on board when choosing a site.

5.54 For both piped and cylinder gases, ensuring priority user status with the supplier will:

- better ensure supply in case of emergency; and
- reduce problems of storage and fire safety.

Ventilation systems

5.55 Ventilation systems are installed throughout healthcare premises to fulfil a number of purposes, some of which have resilience implications. Factors such as smoke clearance for fire protection are already well understood and documented.

5.56 Hazards and threats that may be considered credible in a healthcare facility might include the spread of:

- airborne infections;
- waterborne infections;
- chemical or biological contaminants brought in on casualties;
- a contaminant deliberately released in a healthcare facility. Such a contaminant need not be in itself dangerous – but the impact of a cloud of coloured vapour in a crowded reception may be significant.

5.57 Designers should be briefed that as well as the guidance in HTM 03-01:2007 *Specialised ventilation for healthcare premises*, they should consider ventilation schemes across the entire facility and make an assessment of the flow of air based on developed pressure differentials. This is already commonplace in smaller areas of hospitals such as operating suites, but holistic consideration of the ventilation profile will enable better assessment of likely contamination routes and – if properly designed and commissioned – will provide an additional obstacle to the spread of contamination.

5.58 Good practice dictates the positioning of air intakes out of easy reach and the provision of facilities for immediate shut-down and isolation of discrete zones within the healthcare facility from a central location.



- 5.59 HTM 03-01:2007 stresses the importance of ensuring that systems are correctly designed, installed, commissioned and maintained. Resilience requirements do not detract from these, but do reinforce the need for stringent maintenance including regular testing, inspection and cleaning to ensure that systems are operating as designed and will deliver the required function in the event of an incident.
- 5.60 Owing to the higher running costs associated with generating the pressure differentials, it may be felt appropriate that systems have a “normal” (low-pressure) mode and an “isolation” (high-pressure) mode. If such a method is chosen, the control of how the modes are changed should be carefully designed – both in engineering and management terms – to ensure that it is activated at the appropriate times and remains active until no longer required. Both engineering and clinical staff need to be aware of the modes and the consequences of operation.
- 5.61 Risk assessment may indicate the filtration of supply air either full-time or temporarily in times of heightened threat. Consideration should be given to the development of safe changing routines in the event that contamination has occurred.
- 5.62 The three resilience principles (robustness, redundancy and reconfigurability) should be applied to designs to ensure that the ventilation system is:
- robust enough to withstand hazards and threats;
 - redundant in order to allow continued operation in the event of component failure; and
 - reconfigurable in the event of damage – although in such a case, this may be limited to the provision of dampers to ensure that damaged areas are isolated and that pressure gradients can be maintained.
- 5.63 Due consideration should be given to whether ventilation systems should be kept on or turned off during incidents (see also HTM 03-01:2007 *Specialised ventilation for healthcare premises* and WHTM 05-02:2014 (Firecode) *Fire safety in the design of healthcare premises*).

Note

Sealing buildings to increase energy efficiency may lead to a decrease in indoor air quality and/or overheating (unless suitable ventilation is maintained).

Waste disposal

- 5.64 The ability to remove waste from a facility is a critical logistical concern. Site restrictions and hygiene requirements will preclude the storage of waste for any significant length of time. Healthcare facilities typically require a means to dispose of several different types of waste (see below). The area where waste is stored should be secure and well-lit. It should also be sited away from flood risk and contamination sources.



Infectious/clinical/hazardous waste

5.65 When deciding how infectious/clinical waste will be disposed of, consideration should be given to emergency arrangements. Where disposal is outsourced, the issue becomes one of supply chain resilience, but the consequences of this failure may be such that contingency arrangements over the normal contractual arrangements will be required (for example, the provision of a temporary refrigerated store (including body store) or facility). Note that any such temporary arrangements should only be undertaken in full consultation with NRW. See also WHTM 07-01:2013 *Safe management of healthcare waste*.

Refuse/recyclables

5.66 Refuse removal is traditionally outsourced to a municipal or other contractor, thus requiring an assessment of supply chain resilience that may indicate that an area for refuse storage needs to be set aside or an alternative standby arrangement made, which may include an alternative supply chain.

5.67 For further guidance on waste disposal, see WHTM 07-01:2013 *Safe management of healthcare waste*.

IT and communication systems

5.68 Particular care needs to be considered for the electricity supply and cooling systems needed to support IT systems and communication systems/networks (including wireless systems) as these may be critical during an emergency. For example, if the electricity supply should fail, what impact would this have on:

- access to patients' records, patient data and telemedicine;
- electronically held policy and procedure manuals;
- telephones (including voice over internet protocol (VOIP) systems);
- pagers/cardiac pagers;
- printing;
- building management systems (BMS)/site alarms;
- pneumatic tube systems;
- internal communications (for example, email);
- or other essential systems (that is, those used for the ordering of supplies and medications)?



IT systems

5.69 IT resilience should ensure that suppliers plan, deliver and have the capacity to continually improve IT services aligned to business requirements and industry-standard best practice. Suppliers need to have a monitoring procedure to reduce risks of adverse impact on the business through system failures (for example, cyber attacks). Back-up systems and procedures need to be planned and periodically tested to ensure that essential records (such as patient care records) and data are not lost and to ensure that the building management system (or other systems) are not compromised.

IT service continuity management

5.70 Suppliers should communicate their own resilience plans to NHS Wales-funded providers to enable integration into BCPs and to ensure system resilience is able to meet the level of service availability and business requirements. This should include mitigating any risks accordingly and supporting service improvements. NHS Wales-funded providers should ensure appropriate monitoring of service availability is deployed by suppliers.

Telecommunications

5.71 In designing new, or proposing changes to existing, systems, designers should ensure that consideration is given to the requirements of emergency plans and communication-service resilience before decisions are taken.

5.72 Telecommunications systems should be considered from two perspectives:

- the systems themselves may be business-critical (for example in an IT data centre); or
- they may provide a vital function in managing an emergency (for example public address, telephone and paging systems, the Airwave mobile telecommunication system).

5.73 Where the system is business-critical, the resilience principles should be applied to it and any supporting subsystems.

5.74 For both business-critical and emergency situations, designers of telecommunications systems should consider:

- emergency switching of telephones: fall-back telephones should be sited to guarantee the availability of internal communications to all planned refuges and control centres. The public mobile telephone networks should not be relied on in any emergency communications plan, since extreme external events may overload them or force them to be shut down. Unless specific provision has been made for availability of a reduced mobile telephone service for specific individuals and handsets, this service should not be solely relied upon in emergency planning;



- public address (PA) and alarm systems: PA and alarm systems provide the primary means to communicate with service users. In addition to providing systems throughout a facility, consider extending the system (or making provision for extension) into the car park or other waiting areas. PA systems should be on the essential services power supply and should also allow input into the system from multiple locations;
- use of dedicated two-way radios as back-up system (as networks are not always reliable during some incidents (for example, suspected terrorism) when networks may be switched off or lost);
- use of corporate screensavers for post-incident bulletin updates;
- paging and wireless data systems: similarly, these systems may need to be receivable in spaces adjacent to the site that are designated for emergency use;
- in an emergency, the media will be extremely keen to gather information. The security of data links, including audio, should be considered. Some form of encryption may be prudent to enable positive control of information release and protect personal or sensitive information;
- automated meter reading of bulk oxygen or fuel supplies via telemetry systems to the supplier (failure in the system will require manual intervention).

5.75 Digital communication and information is vital to business continuity, and specific plans need to be in place to mitigate any loss of service (see the *National cyber security strategy 2016-2021* (HM Government 2016)). Where the system is business-critical, the resilience principles should be applied to it and any supporting subsystems.

5.76 Home/mobile communication systems will be needed for key staff with whom contact will be required in the event of an emergency or adverse incident.

5.77 Special note should be taken of the need to ensure that batteries of all essential communications equipment are serviceable and fully charged to meet the needs of a prolonged power failure.

Emergency plans for engineering services

5.78 To be resilient, healthcare organisations should be able to restore engineering systems to normal as soon as practicable after an emergency. This will take the form of an emergency plan that will need to be regularly tested and updated, internally as well as with suppliers, to meet changing circumstances.

Note

In all aspects of emergency and resilience planning, NHS Wales-funded providers should ensure engagement with the lead officers for emergency preparedness/civil contingencies.



5.79 Healthcare organisations may encounter such scenarios as:

- unplanned interruption to a utility supply (gas, water, electricity, telecommunications etc);
- unexpected equipment and service distribution failures (telephones, water pipework, medical gases etc);
- a civil incident (act of terrorism, civil disturbance etc);
- an environmental incident (floods, storm damage, overheating or other extreme weather event);
- failure of transport infrastructure leading to the loss of external supplies or facilities that support the healthcare organisation.

5.80 Emergency and resilience planning cannot be carried out in isolation; all arrangements should be agreed through consultation and dialogue (internally and externally).

5.81 Individual services or departments should be encouraged to accept responsibility for contingency arrangements. This is particularly important for services provided through associated contracts (via PFI partners, commercial businesses, service level agreements etc).

Creating an emergency plan supported by resilience capability

5.82 It is important to define the area to which the plan will apply. This may be by site rather than individual buildings to avoid repetition and to embrace the wider service issues. All the estates services and facilities that exist in the range of buildings on-site should be considered. This plan should be considered in conjunction with the risk assessment described in [paragraphs 2.13–2.17](#).

5.83 **Table 1** gives a broad list of suggested topics for consideration. It is not a comprehensive list and may not be applicable to all sites, but it should act as a prompt to establish the “services list” for a particular healthcare organisation.

5.84 All plans should be documented and supported by relevant information. This should be kept up-to-date and under constant review.

Testing the plan

5.85 Plans should be exercised in order to familiarise staff and to test procedures. Duty to exercise plans is contained in *Health and Care Standard 2.1 Managing risk and promoting health and safety* (Welsh Government 2015c)

5.86 Larger and more wide-ranging exercises should be carefully planned and coordinated through the lead officers for emergency preparedness/civil contingencies or lead officers for emergency preparedness/civil contingencies.



- 5.87 These approaches should engage all staff involved in resilience planning for the healthcare organisation so that all lessons learned can be shared across all services and used to update the plans.
- 5.88 Maintaining services is an essential function of the emergency plan. Alternative sources of catering, laundry, waste disposal, transport, energy etc need to be confirmed, and all lines of communication and supply chains regularly tested and reviewed.
- 5.89 It is also necessary to discuss and establish the priorities of clinical services within the plan. These will include life-critical functions (operating theatres, critical and special care areas, neonatal intensive care units, emergency care etc); diagnostic services (imaging, laboratories etc); and clinical support functions (blood, sterile services, pharmaceutical supplies, medical gases, transport etc).
- 5.90 Particular consideration needs to be given to the services supporting critical and special patient requirements. This could include, for example, positive/negative ventilation for immuno-suppressed/infectious patients, intensive care, patient mobility and community care. These examples are not exhaustive, and a comprehensive assessment undertaken by a multidisciplinary group should take place and be maintained, to inform the emergency plan.
- 5.91 Prioritised but flexible, estate and facilities services which underpin clinical priorities will provide a good platform for the organisation to cope with the impact of emergencies, hazards and threats and speed up recovery to provide normal business continuity.

External impact

- 5.92 External influences are perhaps the most difficult element to incorporate into emergency plans due to the wide range of scenarios that could be presented. Consequently, scenario planning for every eventuality is very unlikely and unnecessary; a generic response framework can address most scenarios.



Table 1 Suggested systems and services and building for consideration when creating an emergency plan

System	Services	External Influences
Mains electricity supply Standby generators CHPs UPS + other batteries Emergency lighting Mains water Hot water Treated water (renal etc) Heating, ventilation and air-conditioning Steam Pneumatic air tube systems Building management system Drainage Surface/foul/waste Fuel supplies Gas/oil/other fuels Communications, including wireless systems: <ul style="list-style-type: none"> • telephones (fixed) • mobile • paging CCTV Burglar alarms Door interlocks (access and ingress) IT and patient information systems Nurse call systems Lifts Sterilization and decontamination Piped and cylinder medical gases Fire alarms Refrigeration (food, mortuary, blood supplies, pharmacy equipment etc) Medical equipment Building structure Architectural design features	Catering – patients and staff Key clinical departments (A&E, theatres, critical care etc) Clinical support (pathology/radiology etc) Estates & facilities management (including engineering staff such as Authorised Persons and Competent Persons) Transport Portering Administration support Patient information Cleaning Waste disposal Laundry Medical supplies Fuel supplies Water drainage Security Parking	Mains water contamination Air pollution/quality Flooding Mains sewage treatment failure Transport routes and infrastructure Infestation Civil disturbance Explosion Excavation Terrorism incidents Communications Other severe/extreme weather conditions: <ul style="list-style-type: none"> • high temperatures/heatwaves • extreme cold weather/ice and snow • high winds (windstorms) Fires from adjacent properties Fauna and flora damage

5.93 However, some of the most likely scenarios and the key issues arising should be examined, evaluated and tested to ensure that some form of response is in place for that eventuality (for example, loss of a major utility or external communication links).



Staff functions

- 5.94 The structure of different organisations will mean that staff with varying levels of experience and expertise could be called on to deal with estates and facilities emergencies; hence, there is a need to ensure that regular training and exercises take place involving all staff groups that may be called upon.
- 5.95 Written emergency operational procedures should be easily understood by those people expected to use them. For example, emergencies associated with engineering services should always be handled by qualified, competent and experienced engineers, as the emergency operational procedure may be highly technical.
- 5.96 In many cases, however, standby staff who may be the first to attend an emergency will not have the technical knowledge to make appropriate decisions. If this is the case, emergency operational procedures should be detailed and specific, and should include instruction on where and how to seek assistance from a more experienced colleague at any stage. This instruction should normally include more than one route and more than one level of management (that is, it should have some communication resilience).



Appendix 1

Design proposal review

Impacts of loss of power, water, drainage, sewage and transport – example questions to mitigate impacts on healthcare organisations

This appendix gives examples of the questions that should be asked by the reviewers of a design proposal.

The list of questions given should not be taken as exhaustive; it is intended as a guide to show how to gauge the level of resilience in a proposal.

Understanding the impacts outlined in [Table A1](#) on the ability to deliver healthcare will inform the design team and direct the questions to ask during the planning process.

Scenario 1 – Mains water supply fails for three days

When considering safe water supplies, consideration needs to be given to:

- *Legionnaires' disease: the control of legionella bacteria in water systems. Approved Code of Practice and guidance on regulations* (commonly known as L8)(Health and Safety Executive 2013); and
- the WHTM 04-01:2016 *Safe water in healthcare premises* series.

1 What arrangements exist in the design for supplying water?

2 How will a failure in the supply be detected?

3 Are emergency stocks held in tanks?

3a How much stock?

3b How was this figure arrived at?

3c Is this based on normal rates of consumption or rationed?

3d How will the water in these tanks be kept potable so that it is ready for use immediately?

3e What arrangements exist for turning over the stock?

4 Is there space in the grounds for collapsible temporary tanks?

4a How long will it take to provide this capability (that is, how much notice is required)?



- 4b Does the volume of tank stock allow sufficient time to construct these temporary tanks?
- 4c Will they require pumping arrangements to feed into the existing distribution system?
- 5 Could a borehole and private supply be provided (that is, one procured outside that supplied by the local water vendor)?
- 5a Will this be for emergency use only (may be easier to get an abstraction licence)?
- 6 What engineering controls will be in place if water rationing is part of the response plan?
- 7 Will non-essential supplies be shut off? Manually or automatically (by the BMS)?
- 8 What impact will the loss of water or imposition of rationing have on other services?
- steam boiler/generator plant;
 - centralised sterile services department, operating theatre air-conditioning plant and other medical users;
 - catering, cleaning and other support users.
- 9 What will be the effect of reduced flow on the sewerage system?
- simple trap-water seals may evaporate and allow gases/airborne bacteria to backflow;
 - reduced effectiveness in clearing pipework, build-up of sludge, blockages.
- 10 What is the possibility of using non-potable water from borehole or other source to flush systems?



Table A1 Impacts of power outages and their implications on water, drainage, sewage, IT and transport and the ability of NHS Wales-funded providers to maintain healthcare

Power Outage	<p>Results in reduced ability or inability to maintain critical care which may result in patients being either transferred to unaffected areas or evacuated to other designated facilities.</p> <p>Lifts, hoists and pneumatic air tube systems not working – severely restricting access to full healthcare facilities.</p> <p>Fire safety alarms, CCTV, burglar alarms and associated equipment not working – extreme risk of patient safety and safeguarding the infrastructure.</p> <p>IT, internet and computers going down, therefore limiting access to medical records – can have severe repercussions on patient care.</p> <p>Refrigeration – some medication needs temperature-controlled storage in a medical refrigerator. Impact on continuing patient treatment. Also, if food refrigeration is not available, food will be spoiled; this may affect patients’ dietary requirements.</p> <p>Communication systems – patients unable to contact emergency services; impact on mobile phone networks; inability to recharge mobile phones or portable/cordless phones and two-way radios.</p> <p>No electricity to recharge essential equipment.</p> <p>Lighting inadequate or in some instances not provided – inability to deliver patient care (for example operating theatre lists); safety and security issues; impact on patients with visual impairment; impact on people with mental health problems or those with dementia. The ability to maintain essential equipment in limited lighting.</p> <p>Emergency lighting – (as above).</p> <p>Heating, cooling and ventilation – loss of any of these systems creates a poor care environment with patients too cold in winter or suffering heat exhaustion in summer or respiratory conditions through poor ventilation.</p> <p>Washing machines, dishwashers and catering equipment cannot be used – adequacy of linen supplies and availability of disposable paper plates/plastic utensils etc. Impact on increased waste, storage and cost of disposal.</p> <p>Pumping stations, booster pumps and monitoring mechanisms may not work at their optimum level, causing disruption to water, drainage and sewage – hydration, cleanliness, hygiene, contamination issues (see below).</p>
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<p>Water, drainage, sewage</p>	<p>Power is necessary for pumping and booster pumps and monitoring mechanisms – loss of clean drinking water, hot water for bathing, washing, cleaning and hygiene.</p> <p>Poor drainage leads to back-up water in the pipes – contamination and potential public health issues.</p> <p>Sewage treatment failure – could lead to untreated/undertreated sewage being added directly to streams and water courses, leading to contamination, public health issues and clean-up measures and costs in the future.</p>
<p>Transport</p>	<p>Transport is dependent on fuel and reliant on electricity – that is, fuel pumps.</p> <p>If transport cannot get to and from the site, it is likely to result in issues around:</p> <ul style="list-style-type: none"> • patients’ inability to get to hospital for healthcare • patients calling emergency services for help • staff accessing patients in the community • staff ability to get to hospital to provide an adequate care service • staff on duty not able to go home, leading to stress and exhaustion. • deliveries of essential supplies to hospitals • regular and reliable collection of clinical waste from hospitals
<p>Community health effects</p>	<p>Loss of home care, that is, oxygen or dialysis units.</p> <p>Lack of home care because staff not able to deliver community service.</p> <p>Loss of power in the community impacts on loss of lighting and therefore increase in accidents; loss of cooking and refrigeration affecting ability to have wholesome nutritional meals, hot drinks etc.</p> <p>Adverse mental health reactions to loss of services, that is, trauma, anxiety, depression.</p> <p>The impact means a greater demand on hospital healthcare services.</p>



Scenario 2 – Mains electricity fails for 24 hours

When considering this scenario, consideration will need to be given to prioritisation strategies with suppliers.

- 1 Is the normal supply at HV or LV?
- 2 What external services require mains electricity for delivery?
- 3 Will the local water undertaking be able to deliver water (pump failure?)
- 4 Outsourced suppliers, for example sterile supplies: is there sufficient space allocated within the facility to hold stocks for the anticipated duration of the failure? Will the provider be prepared to invest sufficient capital to hold these stocks?
- 5 What arrangements exist for emergency supply of electricity (that is, temporary generators, quick connections)?

Standby generator

- 6 Is the engine rated for continuous running? (Certain generators are only rated for non-continuous operation, for example 8 hours in a 24-hour period.)
- 7 How much fuel is held? Is there a need for a fuel bowser?
- 8 Is there adequate cooling for the generator to operate for extended periods in midsummer?
- 9 What if the generator is down for servicing on the day?
- 10 Has provision been made in the design for connection of another generator during maintenance?
- 11 Who will provide this additional generator and where will it be sourced from?
- 11a Is there an additional competent person available to supervise the running of the generator while under load?
- 12 Who owns the standby generator: the provider or a subcontractor?
- 12a If it is a subcontractor, how quickly are emergency repairs carried out?
- 12b Consider the implications of a wide-scale incident on this subcontractor's ability to deliver.



Combined heat and power (CHP) plant used as a standby generator

When considering this aspect, refer to *HTM 06-01 Electrical services: supply and distribution.

- 13 What arrangements exist for dumping excess heat in case of low demand? (If this needs water, consider a cascade failure.)
- 14 Does the design use the hospital heating system? (Consider the effect of possibly having to turn on the heating in midsummer to allow the generator to operate.)
- 15 What is the impact of internal failure, for example if a substation or distribution board fails?
 - 15a Can supply be re-routed from somewhere else?
 - 15b Is it possible to attach a portable generator?
 - 15c Who will provide the generator, service it etc?
- 16 What impact will the loss of the non-essential supply have on facility operations?
- 17 How long will it take to recover and clear any backlog of non-essential work?

Scenario 3 – Loss of telephone communications for up to five days

- 1 Which systems use the telephone network?

Internet connection and data centres

When considering this aspect, undertaking a cost/benefit analysis would be necessary to determine the best options to realistically pursue.

- 2 Can supplier orders and deliveries still be tracked?
- 3 Are stock levels of critical supplies sufficient to last for the loss of service, or will manual monitoring of stock levels be required?
- 4 Where will the manpower for manual monitoring come from?

Building management system

- 5 Are satellite sites controlled and monitored from a remote location?
- 6 Could loss of the telephone network and data centres make remote operation impossible?
 - 6a Will systems have to be manually operated (manpower provision, costs)?



- 6b Will systems/plant and equipment operate in less economical modes (increased running costs)?

Plant monitoring systems

- 7 Leased/hired generators and CHP plant often have a telephone connection to the manufacturer to report faults, allow for remote fault-finding, and identify routine maintenance requirements.

- 7a How will a fault be reported if found?

- 7b Will the estates department be aware?

CCTV and security systems

- 8 Remote monitoring of CCTV at an off-site security centre may be a financially viable option for a provider to consider.

- 8a Will this system continue to operate if the telephone network and data centres fail?

- 8b What vulnerabilities would be exposed by this failure?

Appendix 2

Case study. Ysbyty Ystrad Fawr local general hospital

The site for the new 276-bed Ysbyty Ystrad Fawr local general hospital is located on a floodplain. During the various stages of design, proposals were developed to ensure that the hospital remains in operation during any extreme flood event. Thus, the main hospital concourse is located one floor above the floodplain with parking arranged at the lower ground level. Patient and staff areas are sited around a series of enclosed and semi-enclosed courtyards at both the lower ground and upper ground levels.

Extensive flood modelling was undertaken to understand the impact of a flood with regard to the hospital site. In addition, the flood-modelling exercise determined the broader impacts of flooding and displacement on the wider community.



Aerial view of Ysbyty Ystrad Fawr. ©Bam Construction Limited

A2



View showing the car park below the elevated building. ©Philip Handforth Professional Photos



Further view showing elevated building ©Philip Handforth Professional Photos



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Well-being of Future Generations (Wales) Act 2015 <http://www.legislation.gov.uk/anaw/2015/2/contents>

British Standards Institution

The latest version of any standard should be used, provided that it continues to address the relevant requirements of these recommendations <http://shop.bsigroup.com/en>

BS ISO 22301:2014 *Societal security. Business continuity management systems. Requirements.*



NHS Wales Shared Services Partnership - Specialist Estates Services

Health Technical Memoranda (HTMs) and Health Building Notes (HBNs) issued by the Department of Health in England are being superseded by specific Welsh editions which will be titled Welsh Health Technical Memoranda (WHTMs) and Welsh Health Building Notes (WHBNs) and which will use the same numerical coding. The guidelines referenced below were the most recent at time of publication; however, **the latest version should always be used, provided that it continues to address the relevant requirements of these recommendations**. All are available from the NHS Wales Shared Services Partnership – Specialist Estates Services websites:

Intranet: <http://howis.wales.nhs.uk/sites3/page.cfm?orgid=254&pid=39106>

Internet: <http://www.wales.nhs.uk/sites3/page.cfm?orgid=254&pid=6142>

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HTM 06-02:2006 *Electrical safety guidance for low voltage systems*

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